



Installation, Setup and Operation **INSTRUCTIONS**



for



SUNNEN® **VERTICAL HONING MACHINE** (FOR AUTOMOTIVE & INDUSTRIAL APPLICATIONS) **Model SV-10**

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY AND CAREFULLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THE SUNNEN® AUTOMATIC VERTICAL HONING MACHINE.

SUNNEN AND THE SUNNEN LOGO ARE REGISTERED TRADEMARKS OF SUNNEN PRODUCTS COMPANY.

GENERAL INFORMATION

The Sunnen® equipment has been designed and engineered for a wide variety of parts within the capacity and limitation of the equipment. With proper care and maintenance this equipment will give years of service.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY AND THOROUGHLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THIS EQUIPMENT.

IMPORTANT: Read any supplemental instructions BEFORE installing this equipment. These supplemental instructions give you important information to assist you with the planning and installation of your Sunnen equipment.

Sunnen Technical Service Department is available to provide telephone assistance for installation, programming, & troubleshooting of your Sunnen equipment. All support is available during normal business hours, 8:00 AM to 4:30 PM Central Time.

Review all literature provided with your Sunnen equipment. This literature provides valuable information for proper installation, operation, and maintenance of your equipment. Troubleshooting information can also be found within the Instructions. If you cannot find what you need, call for technical support.

Where applicable, programming information for your Sunnen equipment is also included. Most answers can be found in the literature packaged with your equipment.

Help us help you. When ordering parts, requesting information, or technical assistance about your equipment, please have the following information available:

- Have ALL MANUALS on hand. The Customer Services Representative or Technician will refer to it.
- Have Model Number and Serial Number printed on your equipment Specification Nameplate.
- Where Applicable: Have Drive model and all nameplate data. Motor type, brand, and all nameplate data.

For Troubleshooting, additional information may be required:

- Power distribution information (type - delta, wye, power factor correction; other major switching devices used, voltage fluctuations)
- Installation Wiring (separation of power & control wire; wire type/class used, distance between drive and motor, grounding).
- Use of any optional devices/equipment between the Drive & motor (output chokes, etc.).

For fast service on your orders call:

Sunnen Automotive Customer Service toll free at: 1-800-772-2878

Sunnen Industrial Customer Service toll free at: 1-800-325-3670

Customers outside the USA, contact your local authorized Sunnen Distributor.

Additional information available at: <http://www.sunnen.com> or e-mail: sunnen@sunnen.com

NOTE: Sunnen reserves the right to change or revise specifications and product design in connection with any feature of our products contained herein. Such changes do not entitle the buyer to corresponding changes, improvements, additions, or replacements for equipment, supplies or accessories previously sold. Information contained herein is considered to be accurate based on available information at the time of printing. Should any discrepancy of information arise, Sunnen recommends that user verify the discrepancy with Sunnen before proceeding.

ESD PREVENTION REVIEW

Let's review the basics of a sound static control system and its effective implementation. First, in the three step plan:

1. Always ground yourself when handling sensitive components or assemblies.
2. Always use a conductive or shielded container during storage or transportation. These materials create a Faraday cage which will isolate the contents from static charges.
3. Open ESD safe containers only at a static safe work station.

At the static safe work station, follow these procedures before beginning any work:

- A. Put on your wrist strap or foot grounding devices.
- B. Check all grounding cords to make sure they are properly connected to ground, ensuring the effective dissipation of static charges.
- C. Make sure that your work surface is clean and clear of unnecessary materials, particularly common plastics.
- D. Anti-static bubble wrap has been included for use at the machine when an ESD safe workstation is not available.

You are now properly grounded and ready to begin work. Following these few simple rules and using a little common sense will go a long way toward helping you and your company in the battle against the hazards of static electricity. When you are working with ESD sensitive devices, make sure you:

GROUND
ISOLATE
NEUTRALIZE

SUNNEN® LIMITED PRODUCT WARRANTY

Sunnen® Products Company and its subsidiaries (SPC) warrant that all new SPC honing machines, gaging equipment, tooling, and related equipment will be free of defects in material and/or workmanship for a period of one year from the date of original shipment from SPC.

Upon prompt notification of a defect during the one-year period, SPC will repair, replace, or refund the purchase price, with respect to parts that prove to be defective (as defined above). Any equipment or tooling which is found to be defective from improper use will be returned at the customer's cost or repaired (if possible) at customer's request. Customer shall be charged current rates for all such repair.

Prior to returning any SPC product, an authorization (RMA#) and shipping instructions must be obtained from the Customer Service Department or items sent to SPC will be returned to the customer.

Warranty Limitations and Exclusions This Warranty does not apply to the following:

- Normal maintenance items subject to wear and tear: (belts, fuses, filters, etc).
- Damages resulting from but not limited to:
 - › Shipment to the customer (for items delivered to customer or customer's agent F.O.B., Shipping Point)
 - › Incorrect installation including improper lifting, dropping and/or placement
 - › Incorrect electric power (beyond +/- 10% of rated voltage) including intermittent or random voltage spikes or drops
 - › Incorrect air supply volume and/or pressure and/or contaminated air supply
 - › Electromagnetic or radio frequency interference from surrounding equipment (EMI, RFI)
 - › Storm, lightning, flood or fire damage
 - › Failure to perform regular maintenance as outlined in SPC manuals
 - › Improper machine setup or operation causing a crash to occur
 - › Misapplication of the equipment
 - › Use of non-SPC machines, tooling, abrasive, fixturing, coolant, repair parts, or filtration
 - › Incorrect software installation and/or misuse
 - › Non-authorized customer installed electronics and/or software
 - › Customer modifications to SPC software

THE LIMITED WARRANTY DESCRIBED HEREIN IS EXPRESSLY IN LIEU OF ALL ANY OTHER WARRANTIES. SPC MAKES NO REPRESENTATION OR WARRANTY OF ANY OTHER KIND, EXPRESS OR IMPLIED, WHETHER AS TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER MATTER. SPC IS NOT RESPONSIBLE FOR THE IMPROPER USE OF ANY OF ITS PRODUCTS. SPC SHALL NOT BE LIABLE FOR DIRECT, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES INCLUDING BUT NOT LIMITED TO: LOSS OF USE, REVENUE, OR PROFIT. SPC ASSUMES NO LIABILITY FOR PURCHASED ITEMS PRODUCED BY OTHER MANUFACTURERS WHO EXTEND SEPARATE WARRANTIES. REGARDLESS OF ANY RIGHTS AFFORDED BY LAW TO BUYER, SPC'S LIABILITY, IF ANY, FOR ANY AND ALL CLAIMS FOR LOSS OR DAMAGES WITH RESPECT TO THE PRODUCTS, AND BUYER'S SOLE AND EXCLUSIVE REMEDY THEREFORE, SHALL IN ALL EVENTS BE LIMITED IN AMOUNT TO THE PURCHASE PRICE OF THAT PORTION OF THE PRODUCTS WITH RESPECT TO WHICH A VALID CLAIM IS MADE.

Shipping Damages

Except in the case of F.O.B., Buyer's destination shipments, SPC will not be liable for any settlement claims for obvious and/or concealed shipping damages. The customer bears the responsibility to unpack all shipments immediately and inspect for damage. When obvious and/or concealed damage is found, the customer must immediately notify the carrier's agent to make an inspection and file a claim. The customer should retain the shipping container and packing material.

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Any alteration or reverse engineering of the software is expressly forbidden and is in violation of this agreement.

SPC reserves the right to update the software covered by this agreement at any time without prior notice and any such updates are covered by this agreement.

SAFETY INSTRUCTIONS

READ FIRST

This machine, like any equipment, may be dangerous if used improperly. Please read all warnings and instructions before attempting to use this machine.

Always disconnect power at main enclosure before servicing machine.¹

Always wear eye protection when operating this machine.

NEVER open or remove any machine cover or protective guard with power "ON." Always disconnect power at main enclosure before servicing this equipment.¹

DO NOT attempt any repair or maintenance procedure beyond those described in this book. Contact your Sunnen® Field Service Engineer or Technical Services Representative for repairs not covered in these instructions.

Due to the wide variety of machine configurations, all possibilities cannot be described in these instructions. Instructions for safe use and maintenance of optional equipment ordered through Sunnen, will be provided through separate documentation and/or training provided by your Sunnen Field Service Engineer or Technical Services Representative.

DO NOT attempt to defeat any safety device on this machine or on any of the optional equipment.

If specially built automation components are added to this system, be sure that safety is not compromised. If necessary, obtain special enlarged work area safety system from Sunnen Products Co.

 Indicates CE version ONLY.

¹ DO NOT touch electrical components until main input power has been turned off and *CHARGE* lamps are extinguished. **WARNING:** The capacitors are still charged and can be quite dangerous.

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GENERAL INFORMATION & SPECIFICATIONS

Sunnen® Automatic Vertical Honing Machine - Model SV-10

Bore Diameter Range (I.D.)*:	19,0 to 203,0 mm (.75 to 8 in.) For diameters below 19,0 mm (.75 in) or above 203,0 mm (8 in) call Sunnen in St. Louis
Bore Length Range*:	Up to 450 mm (18 in.)
Workpiece Size*:	1168 L x 558 W x 673 H mm (46 x 22 x 26.5 in.)
Workpiece Weight*:	680 Kg (1496 lbs) including Fixture
Spindle Motor:	2,2 kW (3 hp)
Spindle Speeds:	90 to 350 RPM; Variable
Stroker Motor:	0,75 kW (1 hp)
Stroke Rate:	40 to 80 Strokes Per Minute; Variable
Stroke Length Range*:	0 to 225 mm (0 to 9 in.)
Coolant Pump Motor:	0,75 kW (1 hp)
Coolant Pump Rate:	38 LPM@1,7 Bars (10 GPM@25 psi)
Coolant Capacity:	208 liters (55 gal) with self-contained filter system
Coolant Requirements:	Sunnen Industrial Honing Fluids
Floor Space:	2318 W x 1835 D x 2197 H mm (91.25 x 72.25 x 86.5 in.)
Floor Weight (Dry):	860 kg (1900 lbs)
Floor Weight (W/Coolant):	1050 kg (2300 lbs)
Floor Load:	739 kg/sq meter (151 lbs/sq ft)
Shipping Weight:	1150 kg (2500 lbs)
Voltages Available:	230 V, 60 Hz, 3 Ph; 220 V, 50 Hz, 3 Ph

Automotive Applications

Capacity: V-Blocks, both 60° and 90°; overhead and L-head in-line blocks; angle head blocks; up to 1067 mm (42 in.) long

Cylinder –

Diameter: 76 to 127 mm (3 to 5 in.) with standard hone head. Full range from 51 to 203 mm (2 to 8 in.)

Length: Up to 279 mm (11 in.); 457 mm (18 in.) with special tooling

** Bore diameter, bore length, workpiece size, workpiece weight, and stroke length are contingent on workpiece and application.*

INTRODUCTION

This Instruction Manual provides information required to install, operate, and maintain the Sunnen® Automatic Vertical Honing Machine.


When ordering parts for, or requesting information about your unit, include the serial and model numbers of your machine.

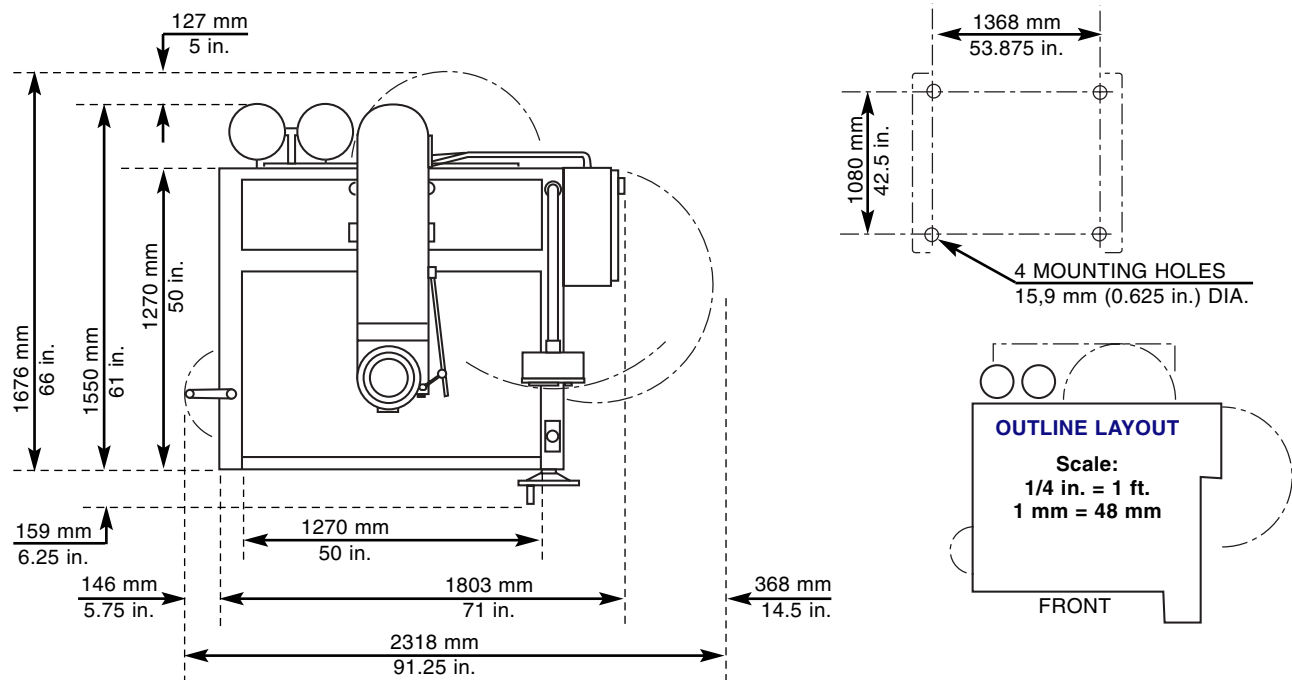
Read the following instructions carefully and thoroughly before unpacking, inspecting, installing or operating your machine.

The Sunnen SV-10 Automatic Vertical Honing Machine continues to set the standards for both industrial and automotive applications for precision and speed for bore sizing and finishing in large workpiece and engine block applications.

INDUSTRIAL: This one machine can handle a wide variety of bore sizing and finishing operations, especially in big, heavy and odd-shaped workpieces that typically present fixturing problems in most horizontal machines.

AUTOMOTIVE: One machine does the total job of re-sizing and finish-honing all the cylinders in any type block.

In this manual the symbol  indicates steps or information that are only for the CE version of this machine. The CE version is constructed to meet the highest level of safety standards as required by the European Machinery Directive. Required for the European market, this CE version is available for any customer. The regular version of this machine is quite safe for any operator exercising a normal degree of caution associated with machine tool use. The CE version provides an extra level of protection by minimizing the risks of operator carelessness.



Weight Installed:
 Approximately 1134 kg (2500 lbs) including coolant.

Floor Loading:
 Less than 617 kg/sm (127 lbs/sf).

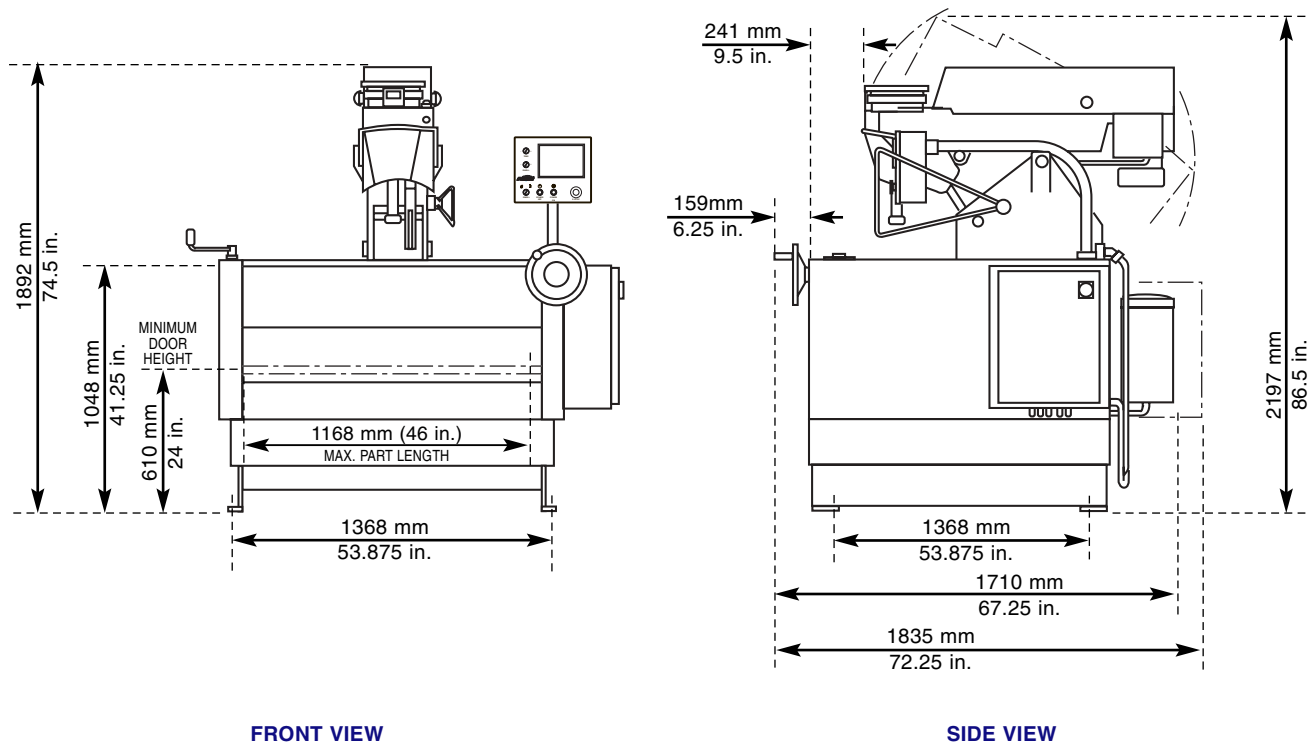


FIGURE 1-A, Machine Layout

SECTION 1

INSTALLATION

PURPOSE

Consult this section when unpacking, inspecting and installing Sunnen® SV-10 Automatic Vertical Honing Machine (see Figure 1-A). Hereafter referred to as the Machine.

SUGGESTED TOOLS & MATERIALS

The following tools and materials are required for unpacking and installing your machine.

Knife	Hammer
Crow Bar	Tin Snips
Slip Joint Pliers	Cleaning Solvent
Screwdriver (Std)	Hex Wrenches
Open End Wrenches	

UNPACKING & INSTALLATION

Read the following instructions carefully and thoroughly before unpacking, inspecting, installing or operating your machine.

All references to right and left in these instructions, unless otherwise noted, are as seen by the operator as one looks at the machine or assembly being described (see Figure 1-1).

NOTE: When ordering parts for, or requesting information about your Machine, include the Model and Serial Numbers printed on the Nameplate of your Machine. The Nameplate is located on the Electrical Control Enclosure.

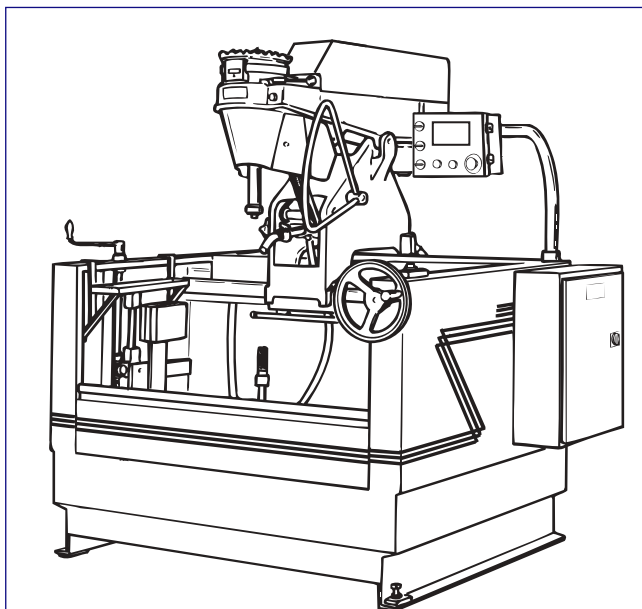


FIGURE 1-1, Automatic Vertical Honing Machine

1. Unpack machine and packaged components carefully and check contents against packing list before discarding any packing material.
2. With packing material removed from under carriage and carriage roller in contact with top rail, set Shoe to have .010 in. (0,25 mm) clearance with bottom of rail (see Figure 1-2).
3. Level machine accurately in desired location using shims and Leveling Screw at front corner of base.

OVERARM SAFETY GUARD

Install Overarm Safety Guard as follows:

1. Unpack Overarm Safety Guard and hardware, and check contents against packing list before discarding any packaging materials.
2. Use hoist to lift guard into position and align hole in guard brackets with threaded holes in machine carriage (refer to Figure 1-2).
3. Secure guard to machine using bolts and lockwashers provided. Tighten bolts.
4. Attach left and right Guard Extensions to Guards using bolts provided. Tighten bolts.
5. Attach left and right Guards to Carriage using bolts and washers provided. Tighten bolts.

NOTE: Use washers (provided) as spacers between Carriage Extensions and Carriage.

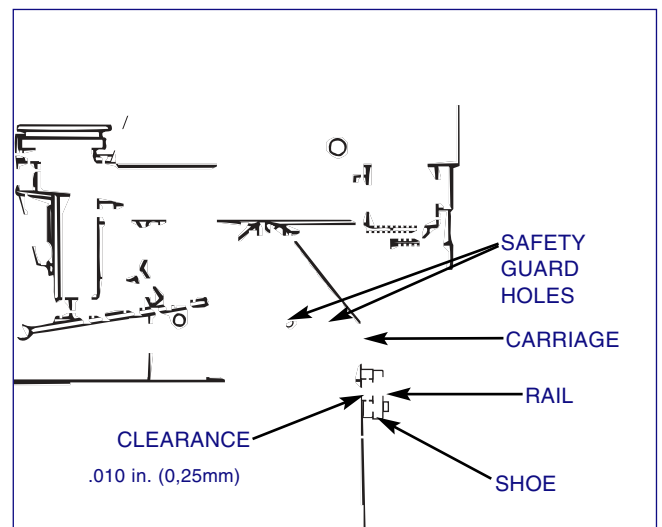


FIGURE 1-2, Overarm

ELECTRICAL CONNECTIONS

All wiring is to be performed by a competent, Licensed Electrician in accordance with all local, state, and federal codes and regulations.

Connect Electrical Control Enclosure (see Figure 1-3) to three-phase power source of voltage and frequency indicated on control panel door.

WARNING

Electrical Equipment, service should be performed by authorized personnel ONLY.

1. Unlock Door to Electrical Control Enclosure.

CAUTION

Door is equipped with lockable Safety Door Latch. Door should be closed and latched during operation to prevent accidental interruption of operation from doors being opened. Door Latch should be Locked-Out and Tagged during servicing to prevent machine from being powered up.

WARNING

You must use the hole provided. Drilling any new holes in the electrical enclosure may void the warranty.

2. Remove hole plug located on top, right side of the enclosure. Then install an oil tight fitting.
3. Install an Oil Tight Fitting (not supplied).
4. Insert Electrical Supply Cord through hole and route to Electrical Disconnect Block.
5. Strip 254 mm (10 inches) off cable's outer jacket.
6. Strip 6 mm (1/4 inch) of insulation off each wire.
7. Connect Green Wire (GRN) to grounding stud as noted in illustration.
8. Connect remaining three (3) wires to Block as noted on Block.
9. Close Door to Enclosure.
10. Route and connect Electrical Supply Cord to factory main power source.

WARNING

☑ Check all guards and insure they are in place and locked before operating machine.

Optional Transformer Kits

Optional Transformer Kits are available for converting 220 or 230 V machines for use with other voltages:

- PEM-1083A used with 230V machines or
- PEM-577A used with 220V machines.

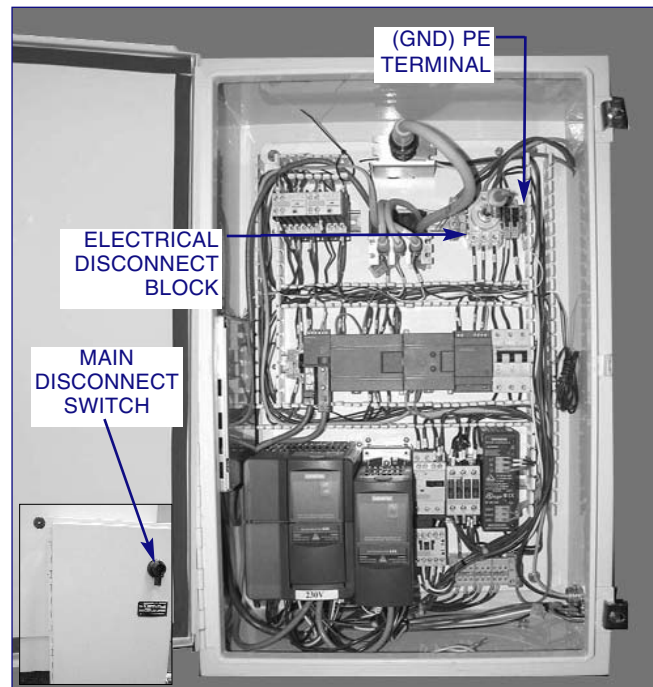


FIGURE 1-3, Electrical Enclosure



FIGURE 1-4, Operator Station

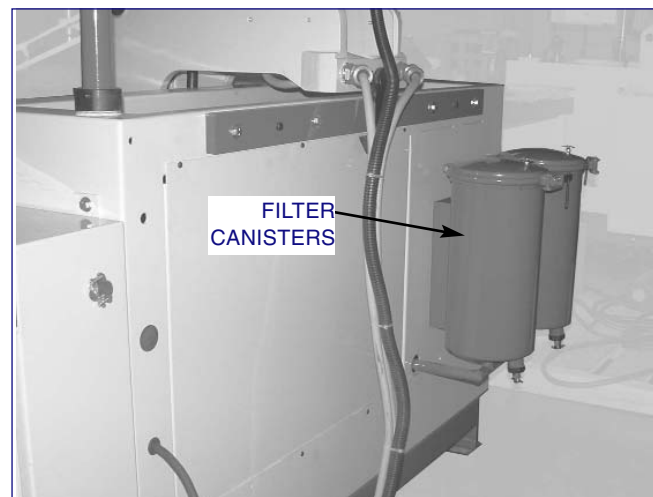


FIGURE 1-5, Filter Elements

CAUTION

A step-down transformer is optional on some machine models. Be certain to verify the transformer KVa rating (where applicable), as well as local electrical code requirements before sizing and installing the incoming power wiring. The end user must use a step-down transformer where factory electrical power varies more than $\pm 10\%$ of the machine's nameplate voltage.

All wiring is to be preformed by a competent, licensed electrician.

Note: Step-down or voltage regulating transformers are external (peripheral) to the machine tool and are considered the primary input line (source) for the machine. Local electrical code or practice may require a circuit breaker or other switching device for the isolation of electrical power when this type of transformer is used. In such cases, the machine tool end user is required to supply the necessary circuit breaker or switching device.

FAILURE TO COMPLY CAN RESULT IN PERSONAL INJURY AND DAMAGE TO THE MACHINE.

OPERATIONAL CHECK

Read Sections 1, 2 and 3 thoroughly and carefully before performing the Operational Check.

NOTE: Power up and start machine to check for proper operation (see Figure 1-4).

A protective foil is installed on the touch screen. This foil **SHOULD** remain in place for operation.

1. Turn ON power at Main Disconnect Switch.
2. Release E-STOP and turn POWER ON.
3. Lower Lift Lever and push Clutch Control Lever Back.
4. Check that pump motor is turning the correct direction according to arrow.
5. If NOT, turn OFF power to Machine and reverse any two wires (red, white, or black) of electrical supply cord, where they connect to Disconnect Block.
6. Operate Machine and recheck.


COOLANT

This machine is shipped without Coolant. Fill Coolant Reservoir with either Sunnen Industrial Honing Oil or Sunnen Water-Based Coolant. Refer to Section 4.

FILTER ELEMENTS

This machine is shipped without filter elements installed in Filter Canisters. Install filter elements as follows (see Figure 1-5):

WARNING

 **Check all guards and insure they are in place and locked before operating machine.**

1. Open Door on rear of Machine.
 2. Remove Cover Clamps and Covers.
 3. Remove filter elements from protective bag and insert elements into Filter Canisters, rotating elements slightly while inserting to make them slide down center post more easily.
 4. Replace Covers, centering carefully on rubber gaskets to assure no leakage.
 5. Replace Clamps and tighten.
 6. Partially open Air Vents in Covers.
 7. Fill machine base reservoir with 190 to 210 liters (50 to 55 gallons) of Sunnen Honing Oil. Dump oil into front of machine and let it overflow into reservoir.
 8. Turn main disconnect switch to ON.
 9. Raise front sliding door and direct oil spout downward.
 10. With Power ON, push Clutch Control Lever Back to start pump.
 11. As oil fills filter canisters, air will escape through air vents. When oil appears in air vents, close vents.
-
- NOTE:** Honing oil should flow from oil spout. Control amount of oil by regulating.
-
12. Turn OFF power.
 13. Wipe oil from around air vents.
 14. Close doors.

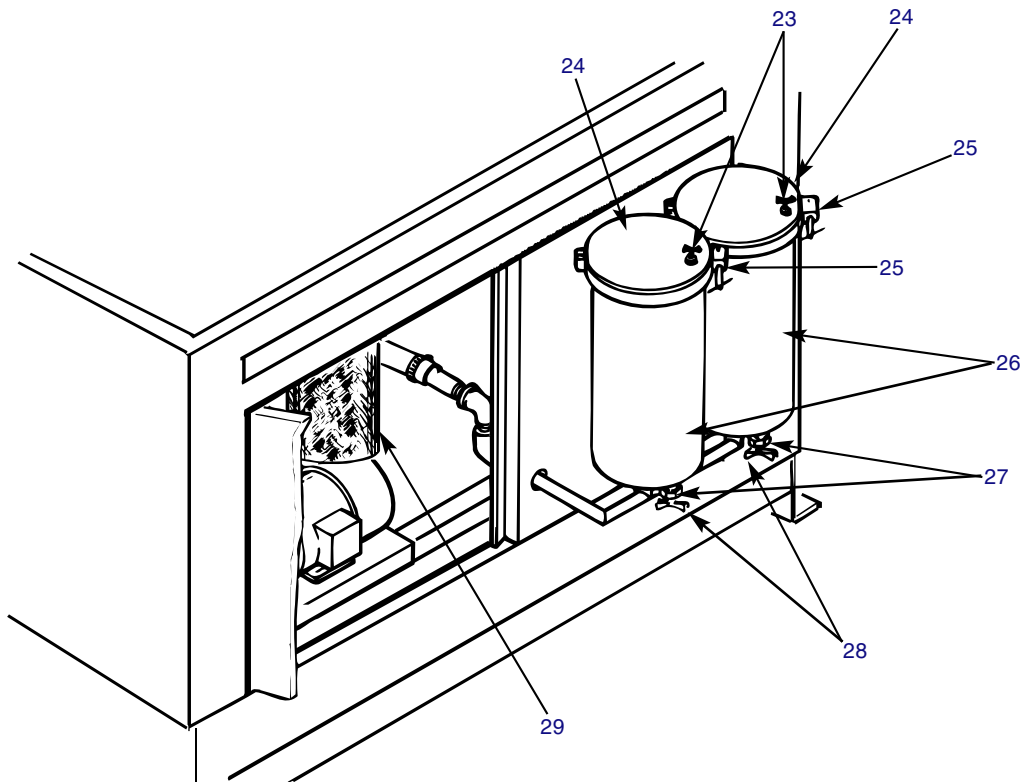
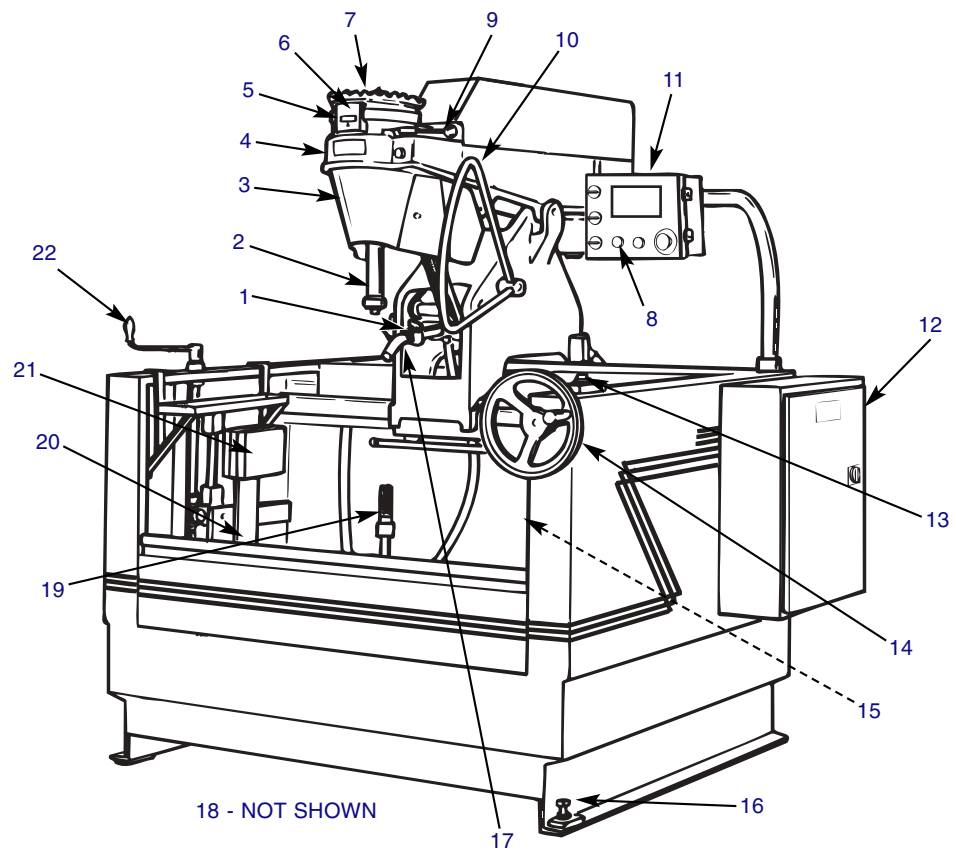


FIGURE 2-1, Major Components

SECTION 2

GENERAL DESCRIPTION

GENERAL

Consult this section when preparing the Machine for operation.

MAJOR COMPONENTS

For the location of the major components on your machine [see Figure 2-1](#).

1. “Oil” SHUT OFF VALVE Regulates flow of honing oil.
2. DRIVE TUBE (Upper Half) Transmits the rotation and stroking motion from the Drive Arm to the Hone Head.
3. DRIVE TUBE GUARD
4. DRIVE ARM ASSEMBLY Produces the stroking and rotational motion.
5. GRADUATED FEED DIAL ASSEMBLY Indicates amount of stone feed, and controls when the honing cycle will stop.
6. INDEX PLATE ASSEMBLY Calibrates each graduation on Feed Dial according to tooling being used.
7. FEED HANDWHEEL Feeds out or retracts stones in Hone Head.
8. “Motor On” INDICATOR LIGHT (Green) Indicate that all motors are on.
9. CLUTCH CONTROL LEVER ASSEMBLY Push back to Start motors; pull forward to engage drive.
10. LIFT LEVER ASSEMBLY Lowers the Hone Head into the bore (cylinder) to be honed.
11. OPERATOR CONTROLS PANEL Houses controls for checking and producing straight bore (cylinder).
12. MAIN ELECTRICAL CONTROL ENCLOSURE Contains electrical controls and main switch.
13. DWELL CONTROL BUTTON Provides a single dwell / continuous dwell when button is depressed / depress & hold for two seconds.

14. “TRAVERSE” HANDWHEEL ASSEMBLY Moves the Carriage and Drive Arm sideways, from bore to bore (cylinder to cylinder).
15. POSITIONING LATCH (Hidden) Used to hold Cradle in correct angular position.
16. LEVELING SCREW Used to level machine.
17. “OIL” NOZZLE Directs flow of honing oil.
18. RISER BLOCKS* (Not Shown) Adapt different sizes and styles of workpieces (style engine blocks) to the Cradle.
19. CLAMPS NUTS* Used to hold workpiece (engine block) to Cradle.
20. CRADLE ASSEMBLY Provides the mounting for the workpiece (engine block).
21. CRADLE COUNTERWEIGHT KIT** Balances offset cradle when honing small parts.
22. ELEVATING CRANK Vertically positions the workpiece (engine block) on the Cradle.
23. AIR VENTS
24. COVERS
25. COVER CLAMPS
26. FILTER CANISTERS
27. STANDPIPES
28. DRAIN COCKS
29. FILTER ELEMENT STORAGE AREA

* Supplied with SV-6200 Clamp Kit (ordered separately).

** Should be removed when honing V-type engine blocks.

OPERATOR CONTROLS

For the function and location of the operator controls, [refer to Table 2-1 and Figure 2-2](#) on page 6.

MACHINE CONTROLS

For a description of other Controls and Warning Symbols used on this machine, [refer to Table 2-2](#).

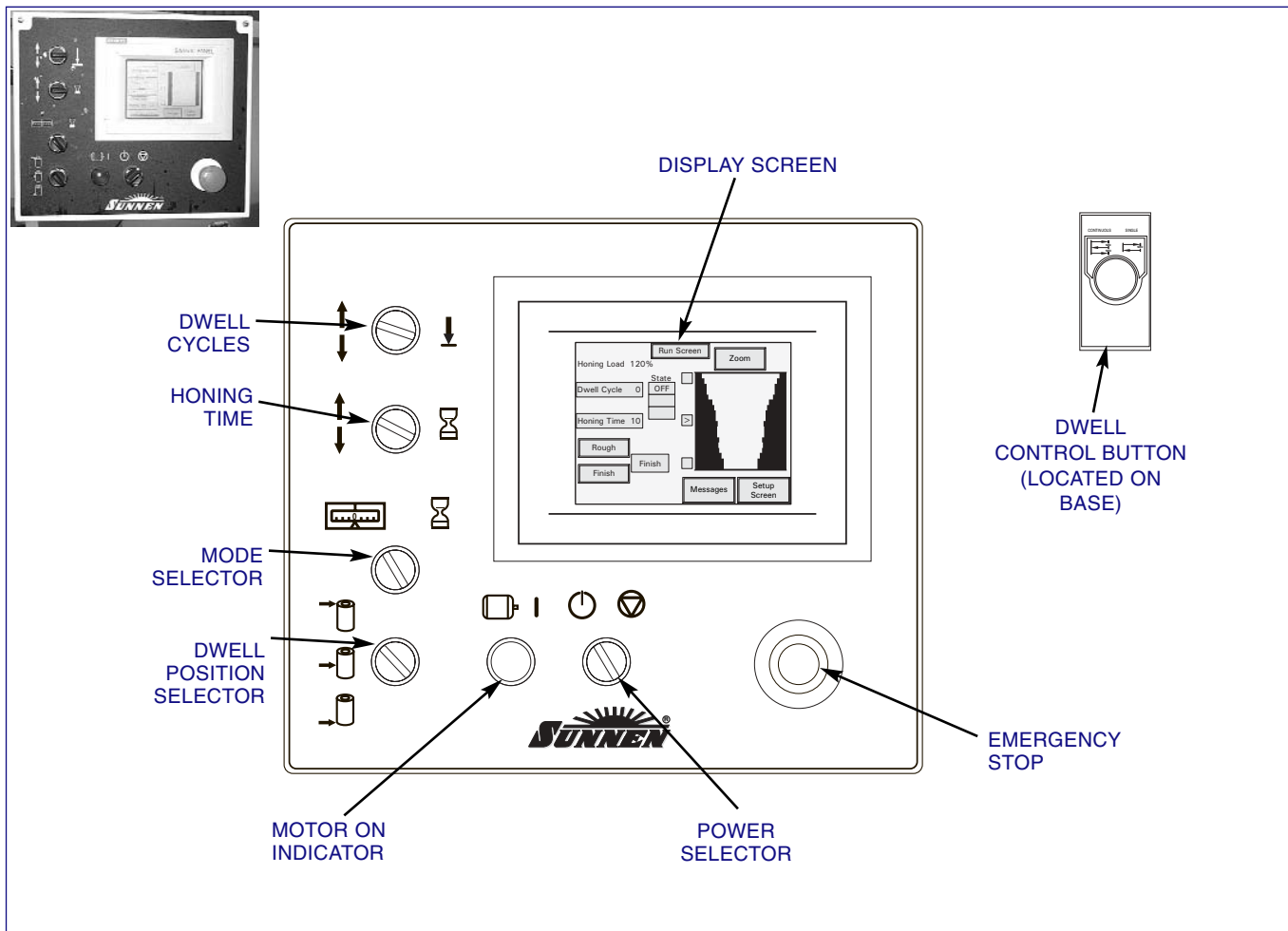


FIGURE 2-2, Operator Controls

TABLE 2-1, Operator Controls












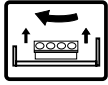
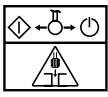



SYMBOL	DESCRIPTION	FUNCTION
DWELL CYCLES 	2 Position Selector Switch	Switch is used to set the number of strokes the machine will dwell at the location selected by the Dwell Position Selector Switch. (Count is found on the Run Screen.)
HONING TIME 	Selector Switch	Switch is used to set honing time in seconds, when a timed cycle is selected. (Time is found on the Run Screen.)
MODE SELECTOR 	2 Position Selector Switch	TIMED – Machine will hone until the number of seconds on the Honing Time display reaches zero. ZERO SHUTOFF – Machine will hone until zero is reached on the Graduated Feed Dial (5).
DWELL POSITION SELECTOR 	3 Position Selector Switch	Switch is used to select position in the bore that the machine will dwell at when the Dwell Cycle Switch or Dwell Button are used.
MOTOR ON INDICATOR 	Motor ON Light	When light is on, indicates that the machines pump is on and the machine is ready to start a cycle.
POWER SELECTOR (ON) 	Selector Switch	Turns ON electrical power to Machine's Operator Controls; places machine in standby mode.
POWER SELECTOR (OFF) 	Selector Switch	Turns OFF electrical power to Machine.
(EMERGENCY STOP) 	Red Locking Pushbutton Switch	Brings machine to an immediate controlled stop & removes all power to the machine functions. Button must be released to continue.

TABLE 2-2, Other Machine Controls & Warning Symbols

SYMBOL	DESCRIPTION	FUNCTION
	Warning Label	Warns that an electrical hazard exists.
	Dwell - Single	Depressing the Dwell Control Button momentarily will result in a single Dwell Cycle at location selected by Dwell Position Selector.
	Dwell - Continuous	Depressing Dwell Control Button for 2 seconds will result in a dwell cycle every cycle at location selected by Dwell Position Selector, until button is pressed again, removing machine from auto dwell mode.
	Cradle Height Adjustment	Indicates direction to turn elevating crank to raise cradle.
	Clutch Control	Indicates that when clutch lever is pushed back to ⌚ position motors are ON and the machine is in stand-by condition. When clutch lever is pulled to ⬅ position honing cycle begins. Warns that the clutch lever should not be pulled forward until honing tool is properly positioned within workpiece.
	Warning Label	Warns that no drilling is allowed. Drilling any new holes may void warranty.
	Warning Label	Warns that safety glasses should be worn at all times when operating this machine.
	Label	Designates this machine is "CE" compliance.

[illegible]

SECTION 3

SETUP & OPERATION

GENERAL

This section gives step-by-step setup and operating procedures for Sunnen® Vertical Honing Machine.

SAFETY PRECAUTIONS

The following precautions should be observed to ensure maximum safety while working on or around your Machine.

- Wear proper Safety Items (such as safety glasses and other personal safety equipment as necessary or required).
- DO NOT wear loose fitting clothes or jewelry while working on or around Machine.
- Keep area around Machine free of paper, oil, water and other debris at all times.
- Keep Machine and area around machine cleaned of excessive lubricant and lubricant spills.
- Keep tools and other foreign objects clear of Machine while in operation.
- Keep tools clean and in their proper storage compartments to maintain them in proper working condition and to prolong tool life.
- Inspect Tools before using. Check for cracks, burrs or bent parts that might effect operation.
- DO NOT force tools when operating. Tools will do a better and safer job when operated at the rate for which they were designed.
- Turn OFF electrical power when performing service on your machine, which does not require power.
- Disconnect Machine from main power supply and allow drives to drain before any work is performed inside of Electrical Enclosure.
- Ensure all Guards are in place and are in proper working order.
- DO NOT override safety switches or lockouts. Where interlocking systems rely on special actuators or keys, DO NOT keep spare/master actuators or keys on, around or near machine.
- Use proper lifting procedures when loading and unloading the Machine.
- Keep all non-essential persons clear of work area. Visitors, especially children, should not be permitted near the work area.
- DO NOT use machine for other than its intended use. Using these Machines for other purposes could result in damage to machine and loss of warranty.
- Be sure to work in a well lit area to avoid dangerous unseen conditions which may exist otherwise.
- Use ONLY factory authorized or recommended parts or replacement accessories. Using parts or accessories other than those approved by Sunnen could result in damage to machine and loss of warranty.
- Electrostatic discharge can damage the circuitry of the electronic components used in this Machine. Use proper electrostatic controls when working with or around electronic components. Ground Machine and use wrist strap to reduce the chances of static discharge.
- Residual Voltage exists for 2-3 minutes after Main Disconnect Switch is turned OFF. Before working inside Enclosure, wait for all fans to stop running to allow drives to drain.

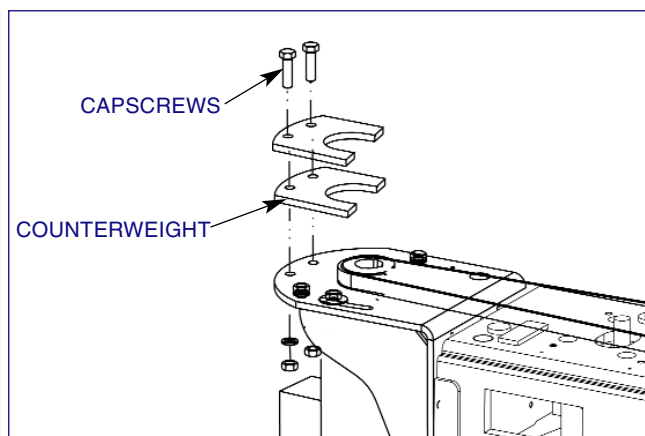


FIGURE 3-1, CV Mandrel Adapter

HONING TOOLS

Refer to Sunnen Industrial or Automotive Honing Supplies Catalogs for all your honing needs

Sunnen offers a wide verity of tooling options within the diameter range of this machine. Including:

CK/CV-Series Hone Heads 51-203mm

DH-Series Hone Heads 54-152mm

The following options require a mandrel adapter:

P20/28-Series Hone Heads 19-152mm

COUNTERBALANCE SETUP

Depending upon the tool type selected, it may be necessary to add or remove weight from the overarm to allow the overarm to stay up when out of the bore and to make the overarm balanced so it is easy to manually raise and lower. To change weights, proceed as follows (*see Figure 3-1*):

1. Turn OFF all electrical power to the machine, at Master Switch on Electrical Control Enclosure.

2. Remove Belt Guard.
3. Locate Counterweights on rear of Overarm (*refer to Figure 3-1*).
4. Position overarm so that the Counterweights are level.

WARNING

Care MUST be taken when removing Counterweight, so they don't fall and cause damage to machine or personal injury.

5. While supporting Counterweights, remove two (2) Capscrews securing weights to Motor Bracket.
6. Add or remove weights until the head stays up when the appropriate tooling is installed in the spindle and the overarm is easy to operate.
7. Secure Counterweights using capscrews removed in step 5.
8. Reinstall Belt Guard.

HONING TOOLS SETUP

For bores with diameters smaller than 60 mm (2.4 in.) or bores over 280 mm (11 in.) long with diameters smaller than 66 mm (2.6 in.), use Sunnen CV-1000 Mandrel Adapter and P28 Mandrels.

P20/P28 Mandrel & Mandrel Adapter

For bores with diameters from 19 to 152 mm (0.74 - 6.0 in.), use Sunnen P20/28-Series Hone Heads (*see Figure 3-2; and Table 3-1*).

NOTE: The Table shows the maximum bore lengths that can be honed by the corresponding tool setups.

Following is a setup guide using mandrel adapter.

1. Slide Drive Tube end of Mandrel Adapter into Drive Tube of machine, and tighten set screw into one of holes (*see Figure 3-3*).
2. Rotate Feed Handwheel to right until it stops, then rotate it one complete turn to left. This positions Feed Link of Mandrel Adapter to connect with mandrel wedge.

3. Rotate mandrel adapter by hand until its set screw points toward you.

Install Mandrel

4. Insert stones into mandrel.
5. Pull back on mandrel wedge, using "V" notch in chuck wrench (*see Figure 3-4*).
6. Place Concentric Sleeve on mandrel, if mandrel requires it (*see Figure 3-5*).

NOTE: Use Concentric Sleeve first. If runout is excessive during honing, replace with Eccentric Sleeve. If runout remains excessive, turn Eccentric Sleeve around.

TABLE 3-1, P28 Mandrels

P28 MANDREL	STONE USED	STONE LENGTH		MINIMUM OVERSTROKE		MAX. BORE* LENGTH POSSIBLE		MAX. BORE LENGTH FOR EASY LIFT-OUT	
		mm	in	mm	in	mm	in	mm	in
2-Stone	1	83	3.3	13	.5	220	8.8	220	8.8
2-Stone	2	167	6.6	25	1.0	210	8.3	210	8.3
3-Stone	2	167	6.6	25	1.0	290	11.6	290	11.6
3-Stone	3	250	9.8	25	1.0	290	11.6	290	11.6
4-Stone	3	250	9.8	25	1.0	380	14.9	380	14.9
4-Stone	4	330	13.1	25	1.0	380	14.9	360	14.2
5-Stone	4	330	13.1	25	1.0	460	18.1	360	14.2
5-Stone	5	420	16.4	25	1.0	460	18.1	280	11.0

* When using a 4 or 5-stone mandrel with 4 or 5 stones, it is possible to hone the lengths listed in the "Max. Bore Length Possible" column. However, it will not be possible to withdraw the mandrel from the workpiece without first lowering or removing the workpiece.

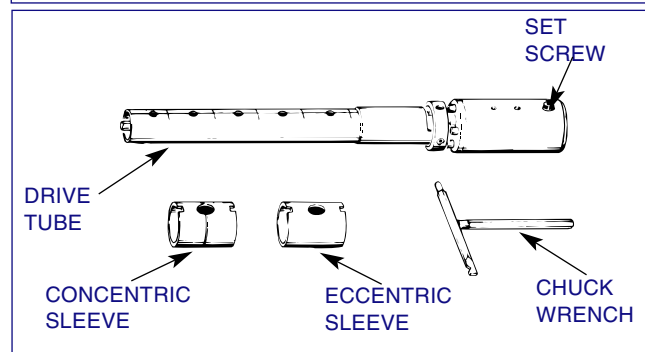


FIGURE 3-2, CV Mandrel Adapter

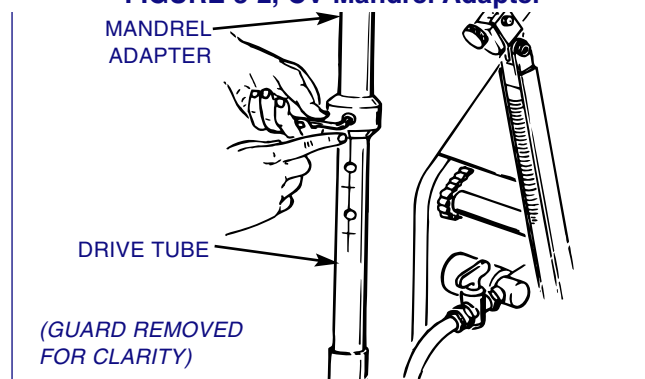


FIGURE 3-3, Install Mandrel Adapter

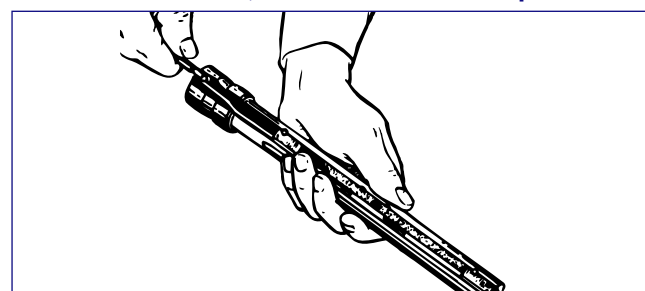


FIGURE 3-4, Mandrel Wedge

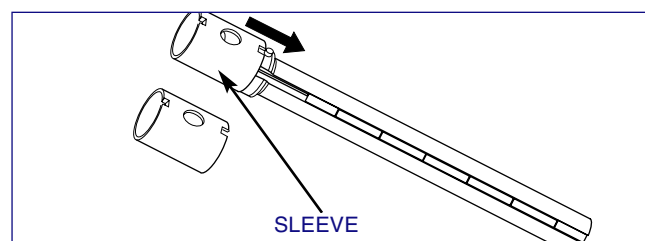


FIGURE 3-5, Sleeve

TABLE 3-2, CV-Series Hone Heads

HONE HEAD	DIAMETER RANGE		STONE LENGTH		MINIMUM OVERSTROKE		MAX. BORE LENGTH	
	mm	in	mm	in	mm	in	mm	in
CV-2400	51- 76	2.0-3.0	76	3.0	13	.5	330	13.0
CV-3000	76-102	3.0-4.0	89	3.5	15	.6	338	13.3
CV-3300	84-127	3.3-5.0	89	3.5	15	.6	338	13.3
CV-4000	102-203	4.0-8.0	152	6.0	25	1.0	381	15.0

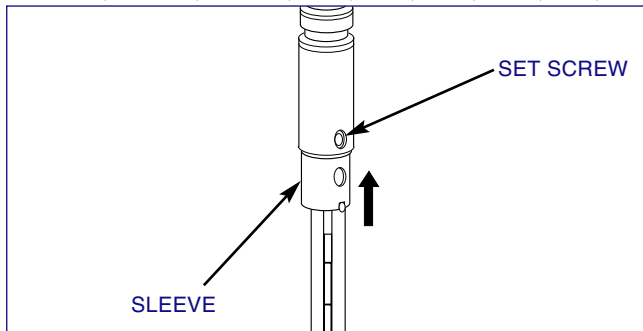


FIGURE 3-6, Install Mandrel

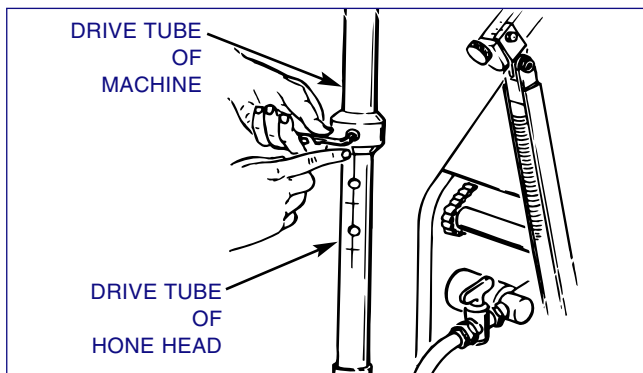


FIGURE 3-8, Install Hone Head

7. Insert mandrel into Adapter (*see Figure 3-6*).

For all "P" series mandrels under 66 mm (2.6 in.), stones should be 90° to right of set screw.

For all "P" mandrels over 66 mm (2.6 in.), stones should be 90° to left of set screw.

8. Push mandrel up into Adapter until it bottoms, rotate it 1/4 turn to right, and push up until it bottoms again.

9. Tighten Set Screw securely with chuck wrench.

IMPORTANT

Test wedge hookup by rotating Feed Handwheel to right. Wedge should travel upward and stones retract. If not, loosen setscrew and repeat steps 2 thru 6. Then check again until wedge does move up when handwheel is rotated to right.

10. Go to Machine Setup.

CV/CK-Series Hone Heads

For bores with diameters from 60-152mm (2.4-6.0 in.), use Sunnen CV-Series Hone Head (*see Figure 3-7 & Table 3-2*).

NOTE: The Table shows the maximum bore lengths that can be honed by the corresponding tool setups.

Install CV/CK-Series Hone Head by sliding Hone Head Drive Tube into Machine Drive Tube; align Locating Screw in Hone Head Drive Tube with one of holes Machine Drive Tube; then, tighten screw (*see Figure 3-8*).

NOTE: Locating Screw can be screwed into hole in lower part of Drive Tube when index lines are in line.

1. HONE HEAD Supports stones and guides. Sides are stamped 1, 2, 3, and 4, and are thus referred to in these instructions.

2. STONE ASSEMBLIES (assembled with Master Holders) Used in Sides #1 and #2 and perform the cutting action.

3. ALIGNMENT GUIDES Assures correct wear pattern of Stones.

4. MAIN GUIDE (used in Side #3) Maintains centering and alignment of hone head in cylinder.

5. CENTERING GUIDE (used in Side #4) Used to assure proper centering of hone head.

6. STONE SHIMS Used to extend range of Stone Assemblies.

7. GUIDE SHIMS Used with Main and Centering Guides to center hone head in cylinder.

8. STONE INSERTER Used to insert stones in Master Holders.

9. SETTING GAGE Indicates thickness of Shims required to set Guides and Stones to cylinder diameter. Also used to adjust Alignment Guides.

10. DRIVE TUBE Connects Hone Head to Machine.

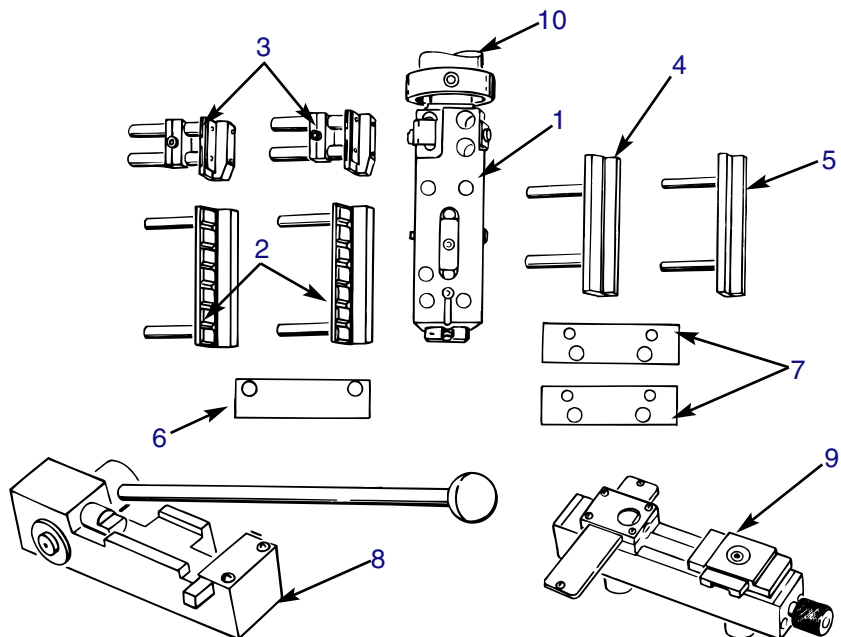


FIGURE 3-7, CV Hone Head

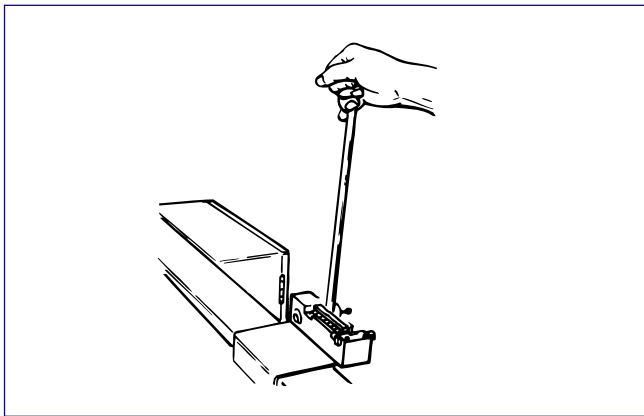


FIGURE 3-9, Remove Stones

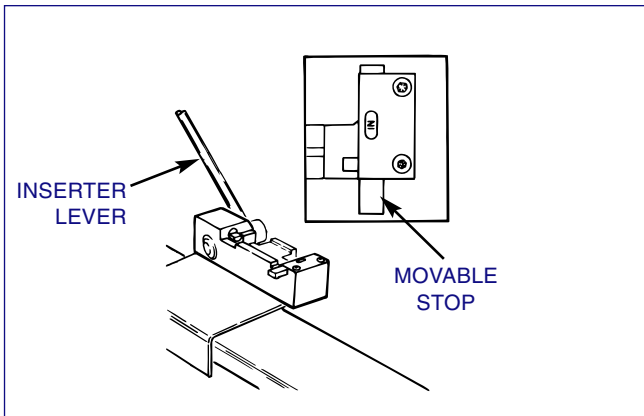


FIGURE 3-10, Open Position

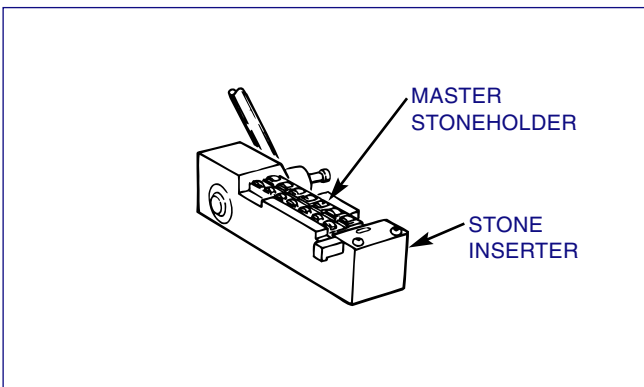


FIGURE 3-11, Master Stoneholder

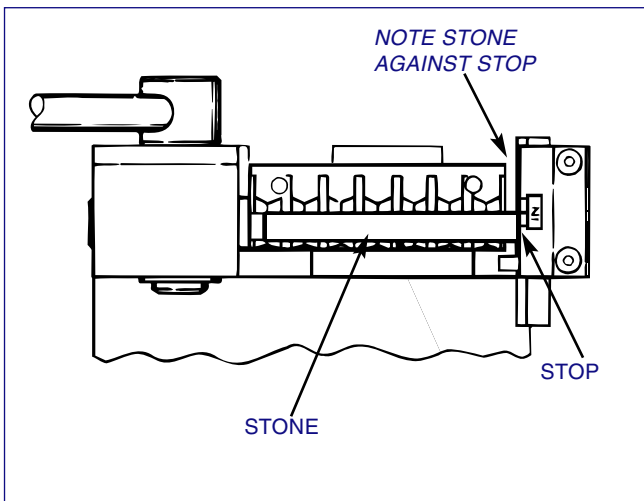


FIGURE 3-12, Install Stone

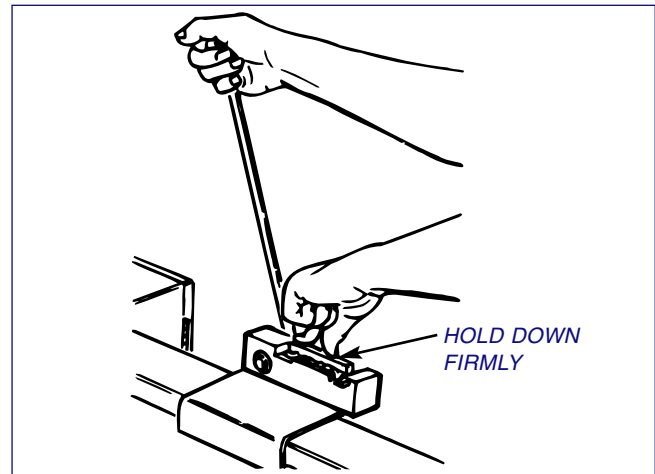


FIGURE 3-13, Seat Stone

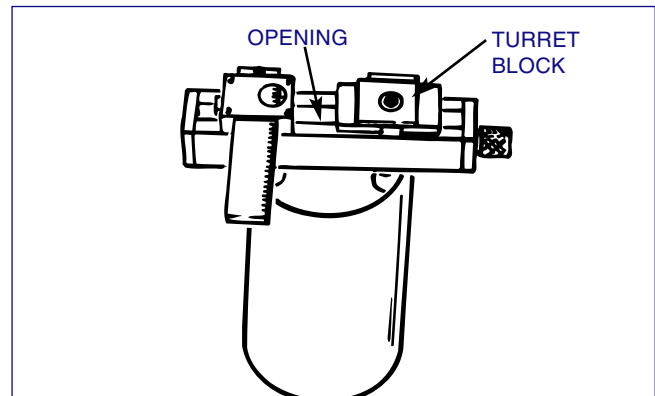


FIGURE 3-14, Setting Gage

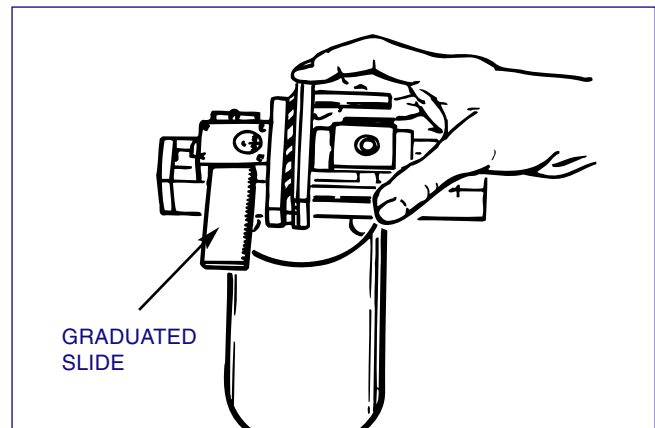


FIGURE 3-15, Stone Assembly

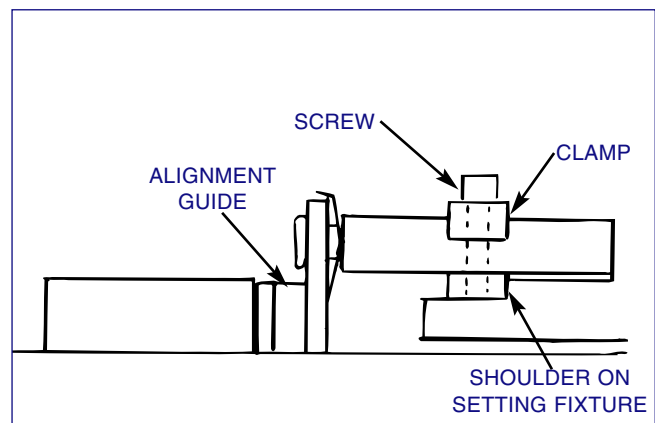


FIGURE 3-16, Alignment Guides

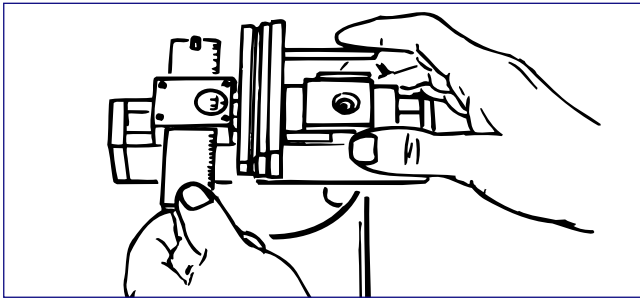


FIGURE 3-17, Main & Centering Guides

Replacing Stones

To replace stones in CV/CK-Series Hone Head, proceed as follows:

1. Slide Movable Stop to OUT position (*see Figure 3-9*). Insert Stone Assembly with worn-out stone into fixture and pull lever toward you until stone is free from master stoneholder.
2. Brush chips and grit from Master Stoneholder slots; slide Moveable Stop to IN position; move lever to open position. Fixture is now ready for inserting new stone.
3. Move Lever to open position and slide Movable Stop to IN position (*see Figure 3-10*).
4. Place Master Stoneholder in fixture. Brush all loose chips from Stoneholder grooves and slots (*see Figure 3-11*).
5. Place Stone in Master Stoneholder (*see Figure 3-12*). Lugs on stone sides should fit into cross slots of Master Stoneholder.
6. Seat Stone in Master Stoneholder by pressing down with fingers (*see Figure 3-13*). Pull lever forward until Stoneholder hits stop. Stone is now in place.

Install Guide/Stone Shims

7. Place Setting Gage in bore to be honed; then snug, making sure to center (*see Figure 3-14*).

NOTE: On CK-3155 Setting Gage, make sure proper side of Turret faces Opening. To correct, loosen screw and rotate index plate until proper hone head is selected.

8. Place Guide/Stone Assembly in Setting Gage with graduated slide set at "0" (*see Figure 3-15 & 3-16*).
9. Move graduated slide so that pin contacts guide. If pin does not contact guide, add a No. 19 shim and try again. Now add necessary shims as indicated on slide. Looseness less than thickness of one shim is acceptable. Special instructions for using CK-4155 Setting Gage for large hone head in 102-203 mm (4-8 in.) range: Move graduated slide so that pin contacts assembly. If graduated slide reads "15" or less, no additional shims should be added; if slide reads over "15", remove assembly from Gage and add one shim.

NOTE: A properly shimmed assembly will slip into gage easily. Both Guide/Stone Assemblies must have same thickness of shims, and each must fit in Setting Gage when assembled with shims.

10. Rotate Drive Tube until numeral "1" appears on Hone Body. Insert one stone assembly with shims in left-hand set of holes beneath numeral.

11. Insert other shimmed Stone Assembly beneath numeral "2", using procedure above.

12. Insert shimmed Main Guide beneath numeral "3" on Hone Body.

NOTE: On CV-2400 & CV-4000 Hone Heads, Centering Guide and Main Guide are identical.

13. Place shimmed Centering Guide beneath numeral "4" on Hone Body.

Alignment Guide

NOTE: DO NOT use alignment guides when honing ported or keyway bores.

14. Place Alignment Guide in setting gage with graduated slide set at "0" (*see Figure 3-17*). Loosen Clamp Screw on alignment guide with hex key wrench and slide to Shoulder. Tighten Clamp and repeat procedure with second alignment guide.

15. Place one of alignment guides in left-hand set of holes above numeral "1" in hone body, so guide and stone are in line.

16. Place other alignment guide in left-hand set of holes above numeral "2" in hone body, so guide and stone are also in line.

DH-Series Hone Heads

Sunnen DiamondHone Multi-Stone Tools comes complete with three hone bodies for bore sizes from 70 to 140 mm (2.75 - 5.55 in.). The DH-Tools use Sunnen Diamond Stone Sets and PHT Brush Sets. The DH Hone Bodies can be quickly changed by removing the three (3) Capscrews securing the Hone Body to the Universal Joint on the Drive Tube (*see Figure 3-18*).

Likewise, the Stone & Stoneholder Assemblies can be quickly changed by unhooking the Springs from the Slot in the top and bottom of the assemblies and sliding the assemblies out of the hone body.

Truing Stones

Sunnen diamond abrasive honing stones have been preground to a radius and can be used directly from the box. Bore geometry should be monitored as the stones true in.

WORKHOLDING FIXTURE

Install and align Workholding Fixtures according to instructions packaged with fixtures supplied for your particular application.

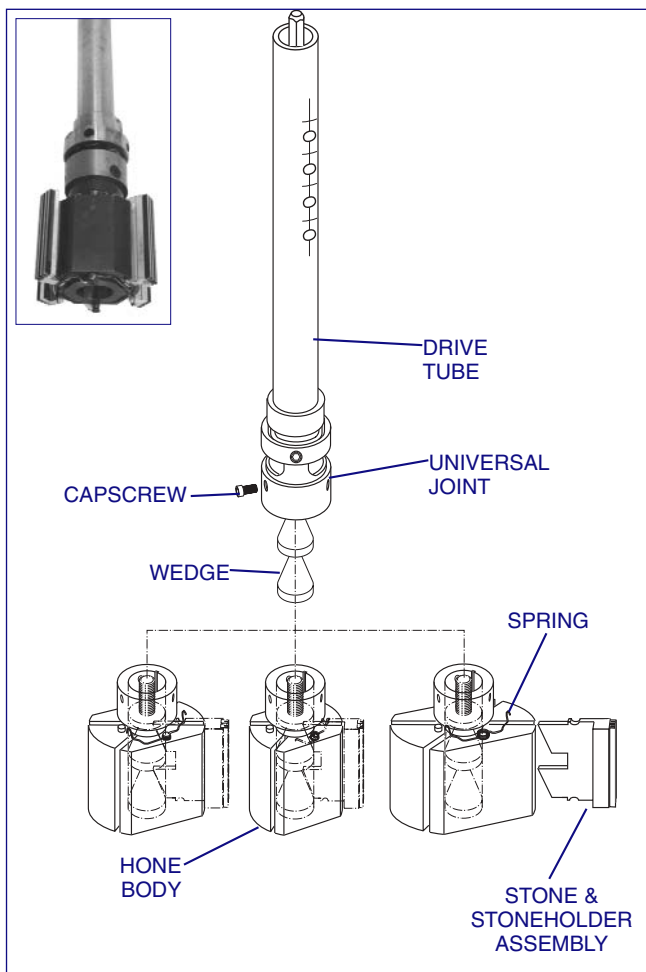


FIGURE 3-18, DH Hone Heads

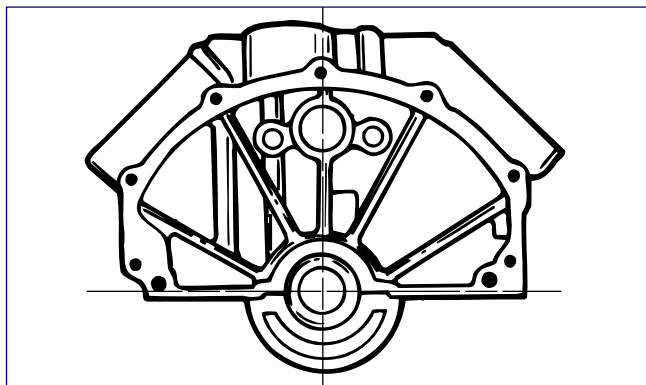


FIGURE 3-19, Main Bearing Centerline

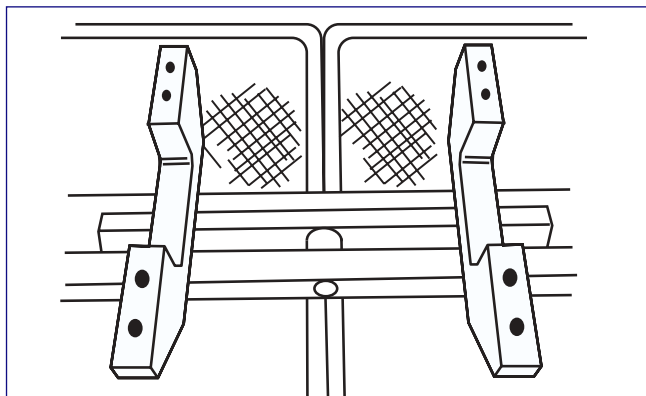


FIGURE 3-20, Riser Blocks

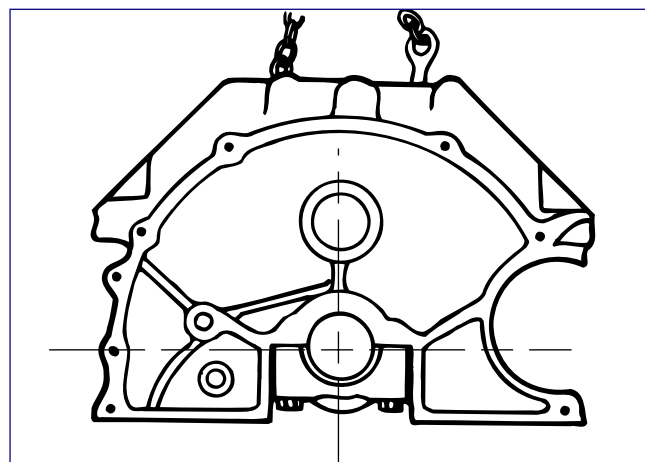


FIGURE 3-21, Main Bearing Centerline

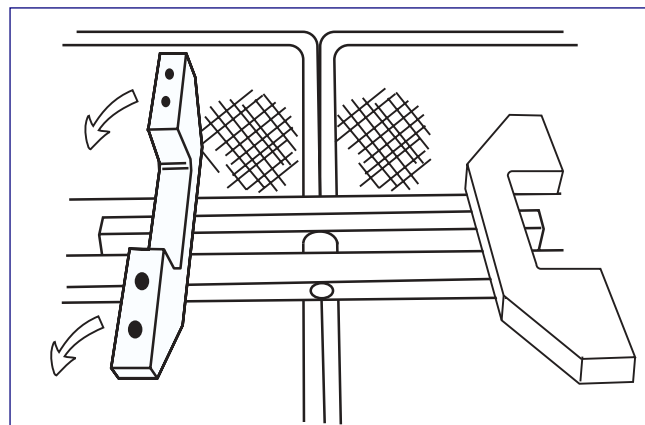


FIGURE 3-22, Riser Blocks

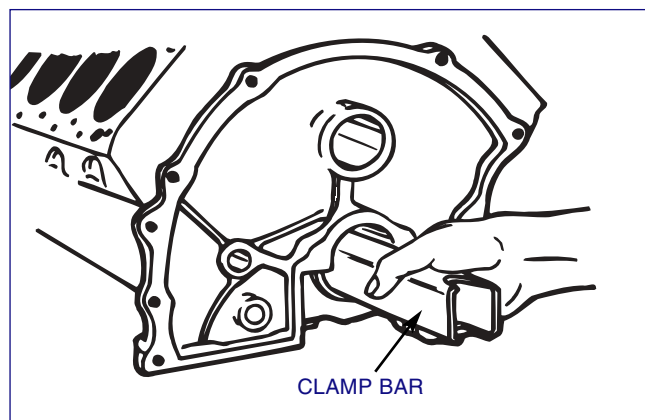


FIGURE 3-23, Clamp Bar

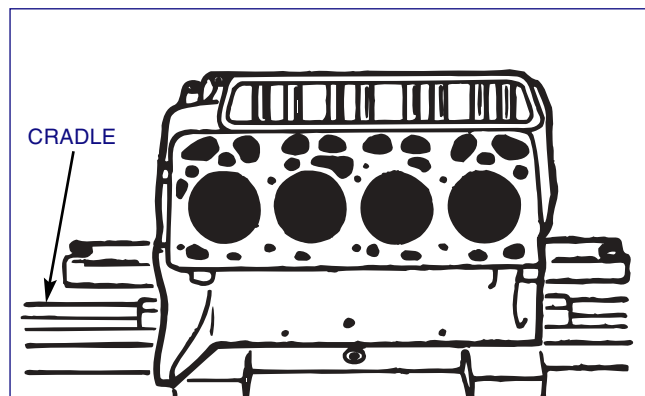


FIGURE 3-24, Position Block

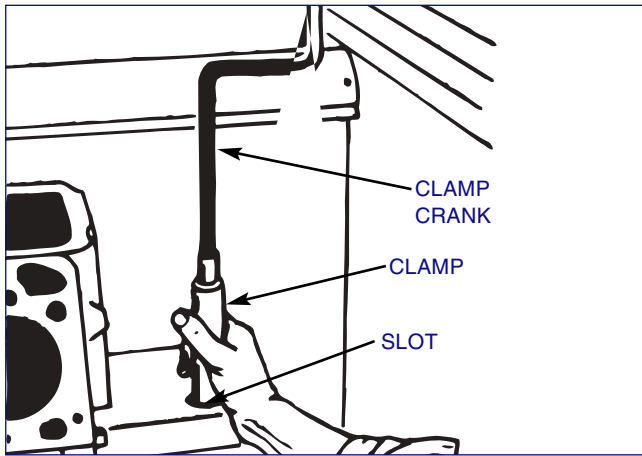


FIGURE 3-25, Clamping

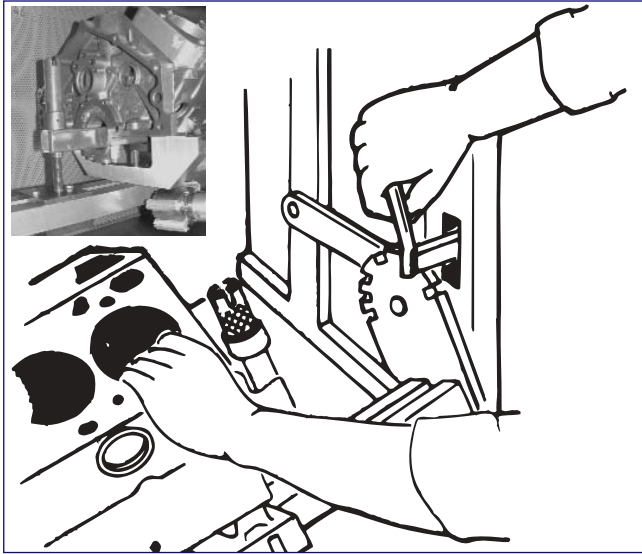


FIGURE 3-26, Rotate Cradle

Automotive Fixture (SV-6200 Clamp Kit)

For Loading Engine Blocks into Machine proceed as follows:

1. Positioning Riser Blocks for In-line and V-Blocks.
 - If engine block's main bearing centerline is in line with pan rails (*see Figure 3-19*), position riser so that it is in a vertical position (*see Figure 3-20*). Large notch in center will provide clearance for main bearing housings. If pan rails are below centerline, position risers so they are in a flat configuration.
 - If main bearing centerline is above pan rails (*see Figure 3-21*), turn riser blocks 90 degrees to flat position, so that pan rails sit on flat part of risers (*see Figure 3-22*).

NOTE: To clamp engine block in place, there must be at least 2 main caps in place. Block distortion will be kept to a minimum if all caps are in place and tightened to proper specification.

2. Place clamp bar through main bearing bores (*see Figure 3-23*).
3. Move carriage to extreme right and raise arm.

4. Make sure that pan rails are clean and free of any gasket material.
5. Slide riser blocks to approximate position near ends of engine block, with proper orientation for that type block.
6. Place engine block on riser blocks near center of Cradle (*see Figure 3-24*).
7. Slide Clamps to slots in ends of Clamp Bar (*see Figure 3-25*). It may be necessary to shift position of engine block so that both Clamps will slide into slots at ends of Clamp Bar.
8. With both Clamps in position, tighten Clamp Nuts evenly - first by hand, and then with Clamp Crank (provided in fixturing package) – so that engine block is held firmly to Cradle. In-line Engine Blocks are now in a position to be honed. .
9. If engine is of in-line type, it is now ready to be honed. If it is a V-Blocks, release cradle index latch at right end of Cradle, and rotate Cradle and engine block into position for honing (*see Figure 3-26*). First notch from center position is for 60° V-blocks; second notch is for 90° V-blocks. “V” Engine Blocks are now in a position to be honed.

NOTE: There is a notch at 135 degrees to help drain honing oil from engine block.

10. For setup of CK type hone head, refer to Installing Hone Head.

MACHINE SETUP

Getting Started / Setup

1. Turn power on by using switch located on the operator console.
2. Wait for main screen to appear on the machine and select the setup key to take you to the 1st Setup Screen.



MAIN SCREEN

3. You may now enter the specifics of the job you are working on. (i.e. Bore diameter, Bore length, Stone Length, top & bottom over strokes). If you would like to start over, press the clear button to rezero all of the parameters.

You can also switch between inch and metric mode by selecting the “IN” or “mm” button respectively.

Setup Screen 1 of 2

Bore Dia 4.000 in

Bore Length 5.00 in

Stone Length 3.00 in

Overstroke Top 0.38 in

Overstroke Btm 0.38 in

Clear

Next

SETUP SCREEN 1

4. To enter data, simply touch the field with your finger and a keypad will appear that will allow the operator to input the necessary data.

Min: 90 Max: 350

310

A	1	2	3	ESC
B	4	5	6	BSP
C	7	8	9	+ / -
D	E	F	0	.
←	→	↶		

KEYPAD

5. The data entered in this screen is completely optional. This data will allow the machine to calculate recommended stroke and spindle speeds, stroke length, and average cross-hatch angles. The machine will still operate if the 1st setup screen is bypassed.

CAUTION

Beware that if the 1st setup screen is ignored the data presented in the recommended speed, stroke length and x-hatch angle fields will be inaccurate and may cause a dangerous operating condition.

6. Use the next button to proceed to the second setup screen.

Setup Screen 2 of 2

Spindle RPM Recommended 250

Stroke Speed Recommended 80

User Input Rough 300

User Input Rough 80

User Input Finish 140

User Input Finish 80

Avg. X-Hatch Angle Rough 18

Avg. X-Hatch Angle Finish 35

Stroke Length 3.1

Back

Run Screen

SETUP SCREEN 2

Set spindle and stroke speed

7. Using the data input on the Setup Screen 1, the machine presents a recommended Spindle and Stroke speed. Using this feedback, the operator can input both roughing and finishing speeds.

8. To enter the speeds, touch the area of interest with your finger. This will open a keypad that will allow the operator to input the necessary data.

NOTE: Notice on fields that have minimum and maximum conditions that the limits are indicated on the top of the keypad

9. Notice that the avg. X-Hatch angle rough and finish update as the user inputs speeds.

Min: 90 Max: 350

310

A	1	2	3	ESC
B	4	5	6	BSP
C	7	8	9	+ / -
D	E	F	0	.
←	→	↶		

KEYPAD

10. Also located on Setup Screen 2 is the suggested stroke length for this setup.

NOTE: Notice that inaccurate data input on Setup Screen 1 can lead to an inaccurate recommended stroke length and may cause a dangerous operating condition.

11. At this point the operator can select BACK to go back to Setup Screen 1 or proceed to the Run Screen.

Run Screen

Honing Load 73%

Zoom

Dwell Cycles 10

Honing Time 15

Rough

Finish

State

ON

CONT

Event Message Exists

Messages

Setup Screen

RUN SCREEN

Run Screen

Honing Load: Will update as the spindle power requirements change during a cycle. (This is a percentage % of the spindle power used.)

High Load Meter Reading: An initial load meter reading of more than 10% above reading for the previous cylinder indicates:

Feed Handwheel has been manually advanced too far.

Feed Handwheel has been manually advanced too fast.

In either case, the result is a higher than normal stone breakdown and a rougher than normal surface finish for that particular abrasive.

Low Load Meter Reading: An initial load meter reading of more than 10% below the reading for the previous cylinder indicates the Feed Handwheel has not been manually advanced far enough, or it has been manually advanced too slowly. The surface finish left by the prior operation is too rough for the stones being used; therefore, an intermediate stone must be used between the rough and the fine finish honing operation. Stone glazing and smoother than normal surface finishes will result from incorrect Handwheel pressure. Erratic surface finishes and excessive finishing stone wear will result from incorrect Stone selection.

Dwell Cycles: shows the number of strokes the machine will dwell at a location in the bore as selected by the Dwell Position Selector.

Honing Time: displays the number of seconds that the machine will run while in the Timed Honing mode as selected on the operator console.

State: Indicates the state of the dwell function (i.e. off, on, or on continuous). By using Dwell Control Button operator located on the workbase, the operator can push the button one time to dwell the machine 1 cycle. This will switch the state indicator from Off to ON. The operator can press and hold the button for 2 seconds and dwell the machine every cycle until the button is depressed again. This will switch the state indicator from Off to On Cont. Note that the location of the dwell is determined by the Dwell Position Selector.

Rough / Finish buttons: Switches the spindle speed and stroke rate between the rough and finish setup entered on Setup screen 2.

Event Message Exists: This message reminds the operator to go to the message screen to review warnings or errors that may have occurred with the machine.

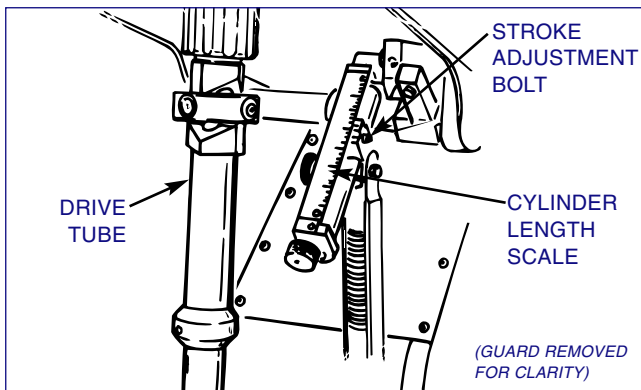


FIGURE 3-27, Stroke Length

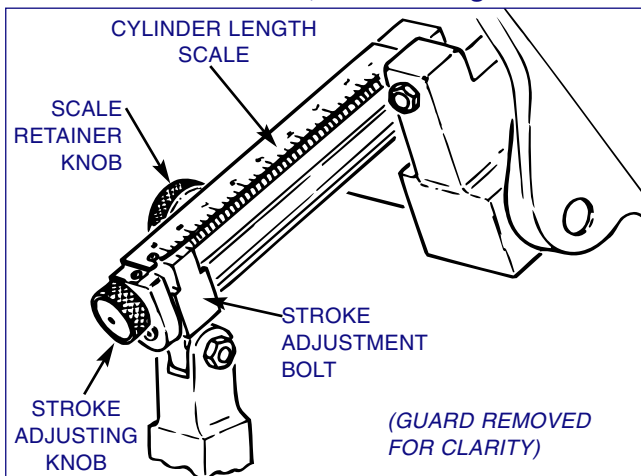


FIGURE 3-28, Stroke Adjustment

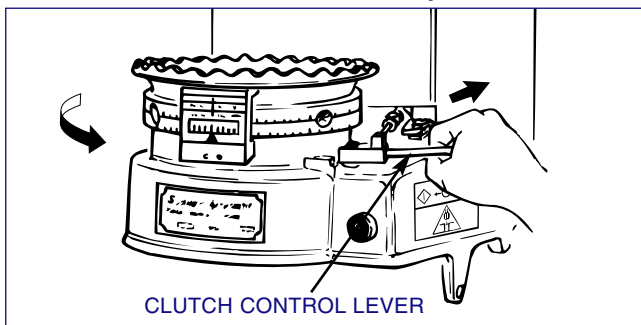


FIGURE 3-29, Clutch Control Lever

Zoom: Touching this button gives the operator a full size screen containing only the honing load and bore profile.

Set Stroke Length

1. Using the value for stroke length on Setup Screen 2, Loosen Stroke Adjustment Bolt and turn stroke adjusting knob so that the index mark lines up with the desired stroke length on the graduated scale (*see figure 3-27*). If necessary use the clutch handle to slowly stroke the machine until the stroke adjustment is easily seen (*see Figure 3-28*).

WARNING

Front splash guard must be raised to uppermost position before operating machine.

☒ Front splash guard is interlocked and machine will not operate if guard is not in uppermost position.

DO NOT pull Clutch Control Lever forward to engage the cycle unless hone head is in bore.

- Turn power ON.

WARNING

Never attempt to adjust stroke length while machine is on or operating. Always close the front guards before operating the machine.

- With the tool in bore and the Lift Lever lowered, push the Clutch Control Lever rearward until the motor on light illuminates (*see Figure 3-29*).
- Slowly pull Clutch Control Lever forward to move the hone up and down.

NOTE: Care must be taken not to bottom the tool out or cause other damage to the machine or tooling.

- Using the Lift Lever, lift the hone until the motor on light goes out to take the machine out of cycle.

2. Tighten Stroke Adjustment bolt. If you do not wish to use the stroke length calculator available in the machine, proceed as follows otherwise go to Set Stroke Position / Overstroke:

3. Measure length of bore to be honed and length of honing stone. The longer of the measurements is the desired stroke length. However, It may be necessary to use less than the desired length if:

- The desired stroke length is longer than 228 mm (9 in), which is the machine limit, or
- The mandrel shank is not as long as the Main Guide, or
- Cutouts or thin walls near end of bore threaten stability of honing tool end of a long stroke, or
- Honing with CV hone head has resulted in bellmouth beyond straightness tolerance required in workpiece.
- Maximum stroke length for blind holes is bore length minus ½ stone length.

4. Rotate Feed Handwheel to right and squeeze stones together until they are completely retracted and hone head will enter the bore.

5. Lower assembled hone head into the bore to be honed by using the Lift Lever.

6. If necessary use the Clutch Control Lever to slowly stroke the machine until the stroke adjustment is easily seen (*refer to Figure 3-29*).

WARNING

DO NOT pull Clutch Control Lever forward to engage the cycle unless hone head is in bore.

- Turn power on
- With the tool in the bore and the Lift Lever lowered, push the clutch control lever rearward until the motor on light illuminates.
- Slowly pull clutch control lever forward to move the hone up and down.

NOTE: Care must be taken not to bottom the tool out or cause other damage to the machine or tooling.

- Using the Lift Lever, lift the hone until the motor on light goes out to take the machine out of cycle.

7. Loosen stroke Adjustment Bolt and turn stroke adjusting knob so that index mark lines up with desired stroke length on the graduated scale (*see Figures 3-30 & 3-31*). Tighten Stroke Adjustment Bolt.

Set Stroke Position / Overstroke

NOTE: Overstroke is the amount that a stone sticks out of the bore at the extremes of the top and bottom of the stroke (*see Figure 3-32*).

8. Use the following formula to determine top over-stroke. Bottom overstroke is equal to top overstroke except for blind holes.

For normal holes:

$$\text{Overstroke} = \frac{\text{Stroke length} + \text{Stone length} - \text{Bore length}}{2}$$

For blind holes:

$$\text{Overstroke} = \text{Stroke length} + \text{Stone length} - \text{Bore Length}$$

9. Slowly stroke machine until the hone head is in its uppermost position and index marks are aligned (*see Figure 3-33*).

WARNING

DO NOT pull Clutch Control Lever forward to engage the cycle unless hone head is in bore.

- Turn power on
- With the tool in the bore and the Lift Lever lowered, push the clutch control lever rearward until the motor on light illuminates.
- Slowly pull clutch control lever forward to move the hone up and down.

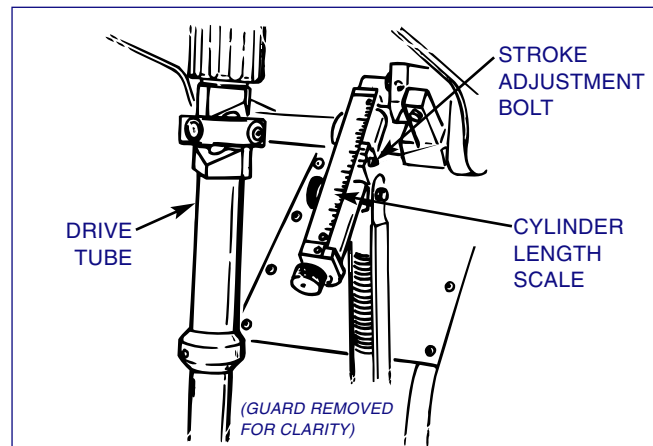


FIGURE 3-30, Stroke Length

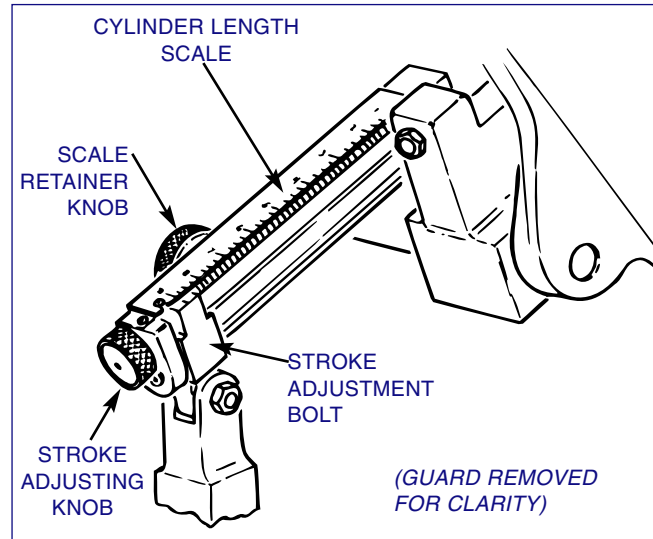


FIGURE 3-31, Stroke Adjustment

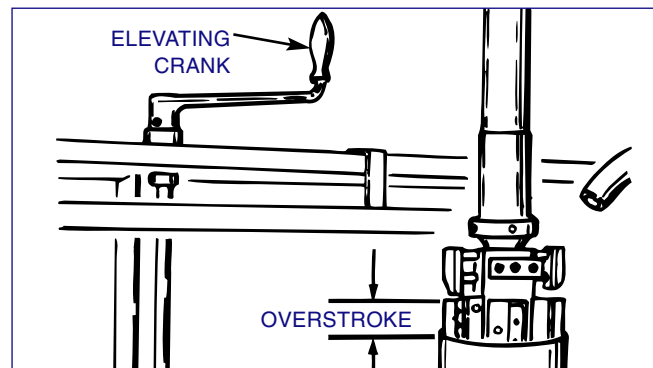


FIGURE 3-32, Overstroke

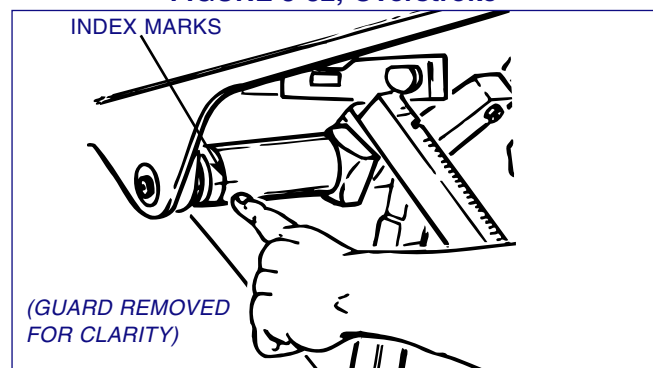
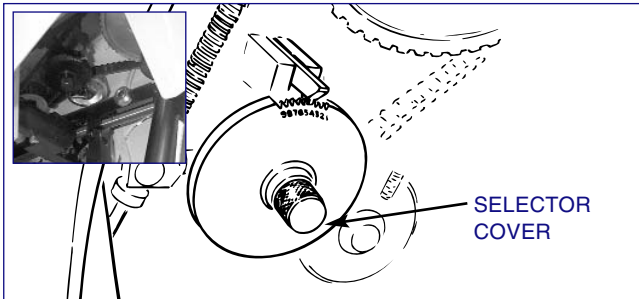
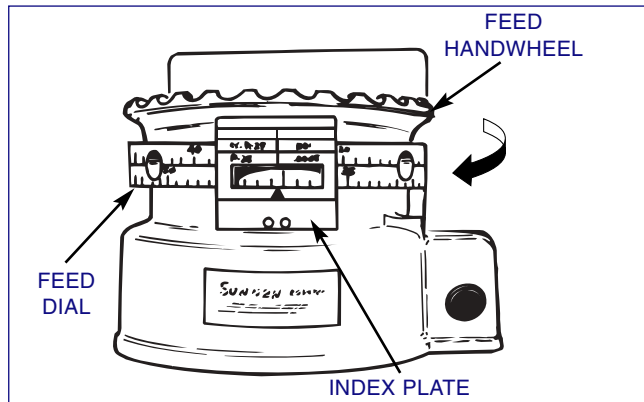


FIGURE 3-33, Stroke Position

TABLE 3-3, Diametrical Feed Rates (in/min)

SPM	Feed Setting	CV/CK	DH
40	1	0.0014	0.0007
	2	0.0027	0.0014
	3	0.0041	0.0020
	4	0.0055	0.0027
	5	0.0068	0.0034
	6	0.0082	0.0041
	7	0.0096	0.0048
	8	0.0109	0.0055
	9	0.0123	0.0061
60	1	0.0020	0.0010
	2	0.0041	0.0020
	3	0.0061	0.0031
	4	0.0082	0.0041
	5	0.0102	0.0051
	6	0.0123	0.0061
	7	0.0143	0.0072
	8	0.0164	0.0082
	9	0.0184	0.0092
80	1	0.0027	0.0014
	2	0.0055	0.0027
	3	0.0082	0.0041
	4	0.0109	0.0055
	5	0.0137	0.0068
	6	0.0164	0.0082
	7	0.0191	0.0096
	8	0.0219	0.0109
	9	0.0246	0.0123

**FIGURE 3-34, Feed Rate****FIGURE 3-35, Feed Dial**

NOTE: Care must be taken not to bottom the tool out or cause other damage to the machine or tooling.

- Using the Lift Lever, lift the hone until the motor on light goes out to take the machine out of cycle.

10. Use Elevating Crank to position workpiece so stone extends above top of bore the amount determined in Step 8 (*refer to Figure 3-32*).

11. If Elevating Crank will not raise or lower workpiece sufficiently to produce required top overstroke,

loosen Set Screw in Drive Tube and adjust length of drive tube as required. Then, tighten set screw.

The Set Screw should be screwed into hole in lower part of drive tube when index lines are in line.

12. Check setup by slow stroking the machine through a cycle.

WARNING

DO NOT pull Clutch Control Lever forward to engage the cycle unless hone head is in bore.

- With the tool in the bore and the Lift Lever lowered, push the Clutch Control Lever rearward until the motor on light illuminates.

- Slowly pull Clutch Control Lever forward to move the hone up and down.

NOTE: Care must be taken not to bottom the tool out or cause other damage to the machine or tooling.

- Using the Lift Lever, lift the hone until the motor on light goes out to take the machine out of cycle.

Set Feed Rate

WARNING

Never attempt to adjust feed rate while machine is on or operating. Always close front guards before operating machine.

☞ Lock front guards before operating machine.

13. Set Selector Cover. Rotate Selector Cover, not knob (*see Figure 3-34 & Table 3-3*).

For rough honing, set Selector Cover to a higher number. (Start at “6” for conventional abrasives in CV-Tooling or “4” for DH-Tooling.)

For finish (most) honing, set Selector Cover to a Lower number. (Start at “4” for conventional abrasives in CV-Tooling or “2” for DH-Tooling.). For faster stock removal or rougher finish, use a higher number.

For greater stone life or smoother finish, use a lower number.

14. Set Feed Dial Index Plate to indicate Honing Tool being used (*see Figure 3-35*).

NOTE: Index Plate has two sides. Slide Plate from holder and invert if correct tooling is not shown on side being observed.

Measuring Taper

15. Gage Bore. Determine amount of stock removal required. If you are rough honing, plan to leave 0,08 mm (.003 in) for finish honing (*see Figure 3-36*).

Check for bore straightness by gaging top, middle and bottom of bore.

The difference in highest and lowest readings is the taper to be removed.

16. Reset Dial Bore Gage so “0” is desired finished size.

OPERATION

Read the rest of the instructions to become familiar with correct honing procedure before starting machine.

Hone First Bore

1. Gage Bore. Determine amount of stock removal required. If you are rough honing, plan to leave 0,08 mm (.003 in.) for finish honing. (Through process development, you can adjust this number.)

As an example, we will assume 0,18 mm (.007 in.) of stock needs to be removed.

2. Rotate Feed Handwheel to right to retract stones.

3. Lower the hone head into the bore (*see Figure 3-37*).

4. Rotate Feed Handwheel to left until snug (a slight resistance is felt); shake Drive Tube to seat stones (*refer to Figure 3-37*).

5. Slide Feed Dial to left until desired stock removal is shown in Index Plate (*refer to Figure 3-37*).

Feed Dial can slide to right on Feed Handwheel. Adjust Feed Dial for amount of stock to be removed. In our example you would move Feed Dial – Feed Handwheel does not move – until it shows 18 for metric machines (7 for domestic machines).

If there were no stone wear, machine would hone bore to size without any additional adjustment. However, there is stone wear, and you must compensate for it on each cylinder if you are going to “hit size”.

As a place to start, assume that 2 units of stock are removed for every 1 unit of stone worn away. If you are finish honing, ratio will be closer to 1 to 1.

NOTE: Do not assume any stone wear if you are using Sunnen metal bonded diamond stones.

Example:

STOCK TO BE REMOVED ESTIMATED STONE WEAR

$$\begin{array}{c} \text{STOCK TO BE REMOVED} \quad \text{ESTIMATED STONE WEAR} \\ \xrightarrow{\hspace{1cm}} .007 \times 1/2 = .0035'' \xleftarrow{\hspace{1cm}} \end{array}$$

STONE WEAR TO STOCK REMOVAL RATIO

$$\begin{array}{c} \text{STONE WEAR TO STOCK REMOVAL RATIO} \\ \xrightarrow{\hspace{1cm}} 0,18\text{mm} \times 1/2 = 0,09\text{mm} \xleftarrow{\hspace{1cm}} \end{array}$$

STOCK TO BE REMOVED ESTIMATED STONE WEAR

Adjust Feed Dial to right for amount of estimated stone wear, that is, 9 marks for metric machines (3-1/2 marks for domestic machines).

You should now read 27 on Feed Dial for metric machines (10-1/2 for domestic machines). This will be referred to as base number throughout these instructions. The base number is always the sum of stock to be removed, added to expected stone wear.

Example:

.0070	(0,18 mm)	STOCK TO BE REMOVED
+ .0035	(0,09 mm)	ESTIMATED STONE WEAR
.0105	(0,27 mm)	BASE NUMBER

Base number is the number that must be represented on Feed Dial when machine is first at full load.

Start Machine

6. Set Mode Selector Switch to Zero Shutoff or Timed:

Zero Shutoff: Machine will hone until zero is reached on graduated feed dial and head is at top of stroke.

Timed: Machine will hone until the number of seconds on Honing Time display reaches zero and head is at top of stroke.

7. Verify the operator interface is on the run screen

8. Clear any event messages. (*see Appendix B for message descriptions and corrections.*)

This is done by selecting messages from the Run Screen. If a message exists, take necessary steps to correct, when complete, select system reset.

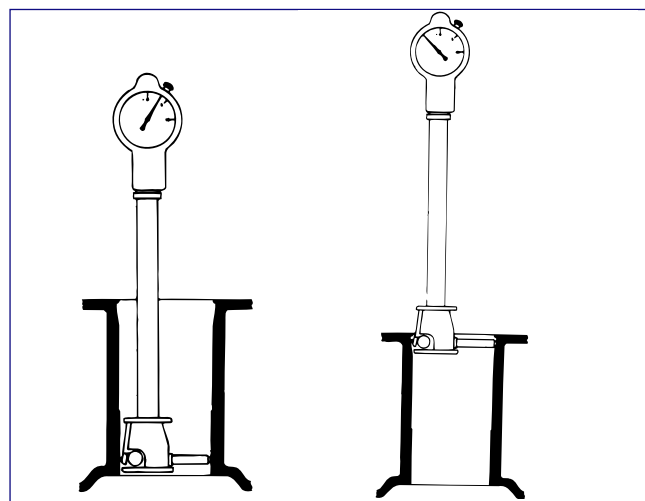


FIGURE 3-36, Gage Bore

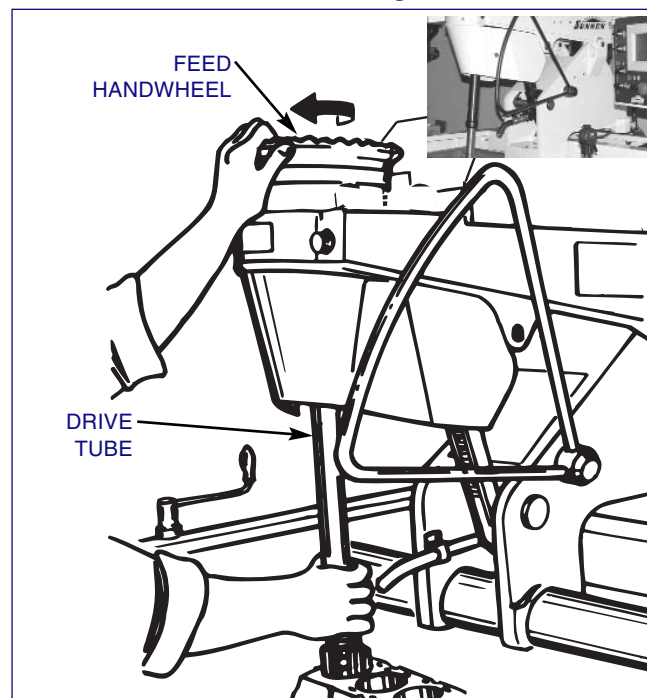
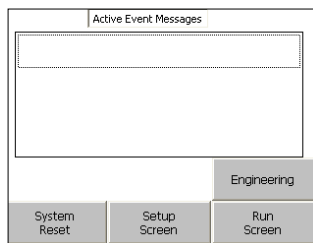


FIGURE 3-37, Feed Handwheel



MESSAGES

WARNING

Front splash guard must be raised to uppermost position before operating machine.

 Front splash guard is interlocked and machine will not operate if guard is not in uppermost position.

9. Raise front panel splash doors.

10. Push clutch control lever rearward to start the pump and place the machine in cycle mode (see Figure 3-38).

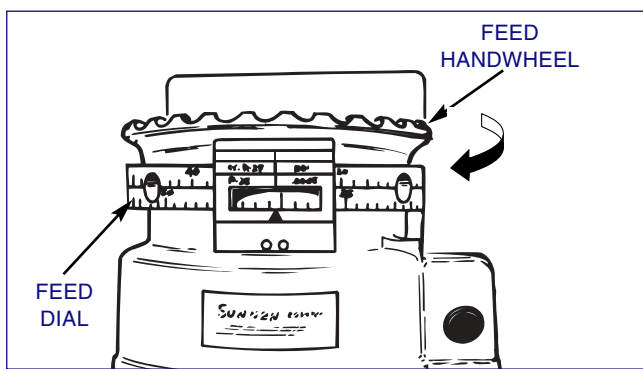


FIGURE 3-38, Feed Dial

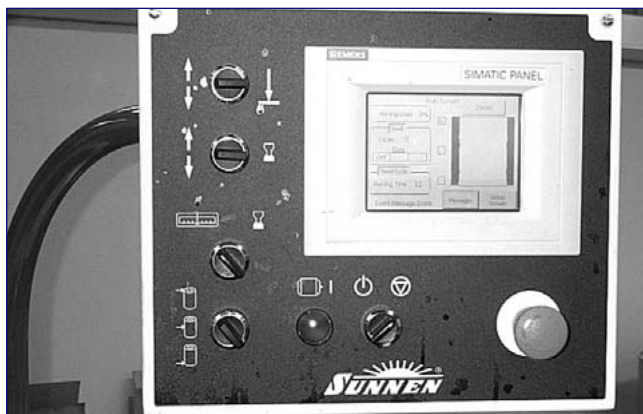


FIGURE 3-39, Dwell Cycle

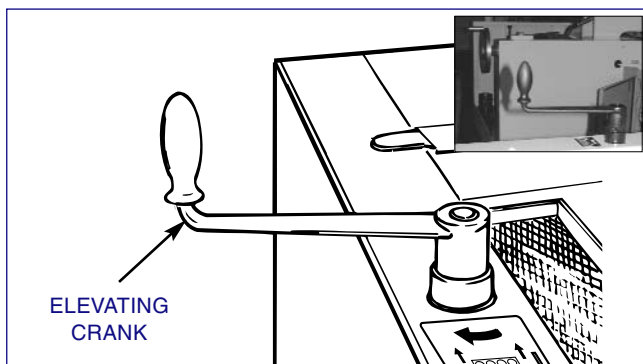


FIGURE 3-40, Dwell

11. Direct Oil Nozzle so that bore receives good flow of oil. Open oil Shutoff Valve.

12. If taper was evident when gaging the bore in step 1, set Dwell Cycle to required number of dwells. Approximately one dwell is required for each 0,025 mm (.001 in.) of taper, as determined in setup (see Figure 3-39).

WARNING

DO NOT pull Clutch Control Lever forward to engage the cycle unless hone head is in bore.

13. Rotate Feed Handwheel to right 5 to 10 marks to slightly unload the tool.

14. Pull clutch control lever forward slowly until it hits the stop. This action engages the spindle and stroker motors.

15. Without hesitating, rotate the Feed Handwheel to the left until the load meter responds to the load (refer to Figure 3-38). As you hone more parts, you will learn what honing load the machine runs at and you will want to feed the handwheel close to this number each time you start a cycle.

16. Using load meter and bore profile, the operator can use Dwell Position Selector, and Dwell Control Button to stop the hone head in the “tight” spot. This will aid the operator in making a straight bore.

NOTE: The elevating crank handle should also be used to better position the workpiece if persistent geometry problems exist (see Figure 3-40).

If the bore profile continually shows a “tight” spot at the top or bottom of the bore, use the elevating crank handle to move the part away from the tight spot.

17. Push Clutch Control Lever back lightly to release Feed Handwheel. (When Clutch Control Lever is pushed back too far, it will start motors; if this happens, push Emergency Stop Button on Remote Control Panel.)

NOTE: In Zero Shutoff Mode, Machine will shut off automatically when Feed Dial moves to “0”. In Timed Mode, Machine will shut off automatically when Honing Time display reaches zero.

18. Rotate Feed Handwheel to right to release stone pressure. DO NOT slide feed dial in relation to handwheel.

19. Raise Lift Lever to remove Hone Head from bore.

20. Gage bore. Bore should be undersize at this point.

21. Place Honing Tool back into bore, squeezing guides to enter bore.

22. Rotate Feed Handwheel to left until lightly snug. Note number on Feed Dial.

23. Hold Feed Handwheel firmly and slide Dial to right number of divisions that gage showed undersize in step 20.

TABLE 3-3, Setup Chart

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
NUMBER	PART LENGTH	STROKE LENGTH	STONE LENGTH	OVERSTROKE	RPM	STROKES PER MINUTE	STONE	FEED RATE SETTING	STOCK REMOVAL	FEED HANDWHEEL MOVEMENT (DIVISIONS)					UNDERSIZE or (OVERSIZE) After Honing	REMARKS
										STOCK REMOVAL deduct Undersize or add Oversize from Col. 16	ANTICIPATED STONE BREAKDOWN	add Undersize or deduct Oversize from Col. 16	EASING IN	TOTAL of Col. 11, 12, 13 & 14		
									.010	10-0=10	0	0	2	12	.003	
									.003	3-3=0	0	3	0	3	.001	
									.001	1-1=0	0	1	0	3	.001	
												4				Use this for anticipated stone breakdown for part # 3.
									.010	10-0=10	4	0	0	16	.000	
									.010	10-0=10	4	0	0	16	(.001)	.001 oversize. Too much anticipated stone breakdown.
									.010	10+1=11	3½	-1	0	15½	.000	
									.012	12-0=12	4	0	0	18	.0005	.0005 undersize. But still in tolerance.
									.012	12-1½=11½	4½	+½	0	18½	.000	

24. Rotate Feed Handwheel to right a few divisions to release stone pressure.

25. Start motors and pull Clutch Control Lever forward.

26. Ease Feed Handwheel to left to develop honing load.

NOTE: In Zero Shutoff Mode, Machine will shut off automatically when Feed Dial moves to “0”. In Timed Mode, Machine will shut off automatically when Honing Time display reaches zero.

27. Repeat [Steps 14 thru 26](#) until FIRST BORE is within size tolerance.

IMPORTANT

At this point, automatic shutoff has been set. Stone breakdown will be determined while honing second bore. Use [Table 3-3](#), while honing second bore to help determine stone breakdown.

28. Adjusting Feed For Bore Being Honed
When last bore was under or oversize, add amount last bore was under or oversized to estimated stone wear for amount. Add to this, difference between original and new stone wear estimate for stock removal in present bore. This is amount you should slide Feed Dial. You will have a new stone wear estimate only if you had to recalculate your stone wear ratio.

Example:

AMOUNT OVER OR UNDER SIZED (FROM LAST BORE)	1.0
STONE WEAR FOR THIS AMOUNT (1 x 3/4 = 3/4 ROUNDED DOWN)	0.5
NEW STONE WEAR ESTIMATE (7 x 3/4 = 5-1/4 ROUNDED DOWN TO 5)	5.0
ORIGINAL STONE WEAR ESTIMATE (7 x 1/2 = 3-1/2)	3.5
DIFFERENCE BETWEEN NEW AND ORIGINAL STONE WEAR ESTIMATES (5 - 3-1/2 = 1-1/2)	1.5
TOTAL	3.0

If last bore was undersize, hold Feed Handwheel still and slide Feed Dial to right number of marks you calculated. In our example it would be 3.

If you were oversize, hold Feed Handwheel still and slide Feed Dial to left number of marks you calculated. In our example it would be 3.

Hone Second Bore

1. Gage Bore to determine amount of stock to be removed.

2. Place Honing Tool into bore.

3. Rotate Feed Handwheel to left until snug. DO NOT slide feed dial in relation to handwheel.

4. Advance Feed Dial number of divisions that you anticipate for stone wear. Remember to hold Feed Handwheel firmly.

Adjust Feed Dial for amount of stock to be removed; plus, you must compensate for stone wear.

Stone wear is equal to total number of divisions that Feed Dial is advanced when honing second bore to size.

NOTE: Do not assume any stone wear if you are using Sunnen metal bonded diamond stones.

5. Release stone pressure.

6. Push Clutch Control Lever toward rear of drive arm to start motors; then, pull Lever forward to start the spindle and stroker.

IMPORTANT

Note starting position on graduated Feed Dial. Stone Breakdown is equal to total number of divisions that Feed Dial is advanced when honing second bore to size.

7. Ease Feed Handwheel to left until Dial indicates amount of stock removal needed.

NOTE: In Zero Shutoff Mode, Machine will shut off automatically when Feed Dial moves to “0”. In Timed Mode, Machine will shut off automatically when Honing Time display reaches zero.

8. When machine shuts off, remove Honing Tool and Gage Bore.

Repeat steps 2 thru 8 until SECOND BORE is within tolerance. Follow rest of example on Setup Chart for remaining bores (*refer to Table 3-3*).

NOTE: Once bore has a honed surface, there is no need to allow feed-up for easing in.

Hone Third & Subsequent Bores

1. Gage Bore to determine amount of stock to be removed.
2. Place Honing Tool into bore.
3. Rotate Feed Handwheel to left until snug. DO NOT slide feed dial in relation to handwheel.
4. Advance Dial number of divisions that you anticipate for stone breakdown. If stock to be removed in third bore is same as for second bore, stone breakdown should be same.
5. Release stone pressure.
6. Push Clutch Control Lever toward rear of drive arm to start motors; then, pull Lever forward to start spindle and stroker.
7. Ease Feed Handwheel to left a few divisions.

NOTE: In Zero Shutoff Mode, Machine will shut off automatically when Feed Dial moves to "0". In Timed Mode, Machine will shut off automatically when Honing Time display reaches zero.

8. When machine shuts off, remove Honing Tool and Gage Bore.

If stone wear was correctly anticipated, THIRD BORE will be within size tolerance. Modify anticipated stone breakdown figure as required to keep subsequent bores within size tolerance. Follow rest of example on Setup Chart for remaining bores (*refer to Table 3-3*). Setup Chart blanks can be obtained by asking for Form No. X-CV-5016.

OPERATING TIPS

If load is consistently over 90%: First try reducing ratchet feed setting. Second: Try reducing SPM. Next: Try increasing RPM. If any of these do not produce a lower steady load use a softer stone.

If load grows through cycle: This could be caused from the crown not being fed up enough at the start of the cycle. The crown should be fed up enough to produce a steady load through the entire cycle. Too low of a starting feed could also lead to glazing of the stone. If feeding up more does not produce a steady load use a softer stone if possible.

If the stone wears out too fast: If the starting surface finish of the part to be honed is rough, increase the number of divisions used for easing in at the start of the cycle. Any starting load higher

than the steady operating load could also increase stone wear. If the above technique is used and the stone life is still not acceptable, lower the feed ratchet setting. If a low steady operating load accompanies poor stone life than increase spindle RPM and use a harder stone if possible.

If stock removal rates or to low: Any of the following should increase stock removal rates as long as the machine load is not excessive. Increase ratchet feed setting. Increase SPM and/or RPM. Use a coarse grit stone. A harder stone may be needed if the higher stock removal rates produce excessive stone wear.

If bore is tapered:

Bore tight at bottom - Set Dwell Position Selector to bottom, and push Dwell Control Button. If taper continues, increase the number of dwells on the console and push Dwell Control Button. Raising the workpiece can also be used if the taper persist. Bore tight at top - Set Dwell Position Selector to top, and push Dwell Control Button. If the taper continues increase the dwell count on the console and/or lower the workpiece.

Stone Wear

To calculate stone wear ratio, divide stock removed by amount stone wore. You get the stock removed by gaging the last cylinder honed. To get the stone wear, subtract stock removed from number used in the last cylinder.

Example:

$$\begin{array}{rcl} 10-1/2 & \text{Base number (from last cylinder)} & \\ - 6 & \text{Stock removed (from last cylinder)} & \\ \hline 4-1/2 & \text{Difference (stone wear: } 10-1/2 - 6 = 4-1/2) & \end{array}$$

$$\text{STONE WEAR RATIO} = \frac{\text{STONE WEAR}}{\text{STOCK REMOVED}} = \frac{4-1/2}{6} = .75 \text{ OR } 3/4$$

Extra Fine Stones

Finishing stones, 280 grit and finer, are available for high performance, competition and test engines, as well as other requirements.

When using these extra fine stones, take care to avoid Glazing, which is caused by insufficient stone pressure or Stone Crumbling, which is caused by too high of a stone pressure.

NOTE: Stones must be fully radiused to cylinder diameter to assure consistent load meter readings and results.

Advance Feed Handwheel smoothly and at a moderate speed to the proper position on each cylinder. When this is done, the initial load meter reading will not vary more than 10% from the final reading on the normal reading of the load meter for that particular abrasive on that particular block.

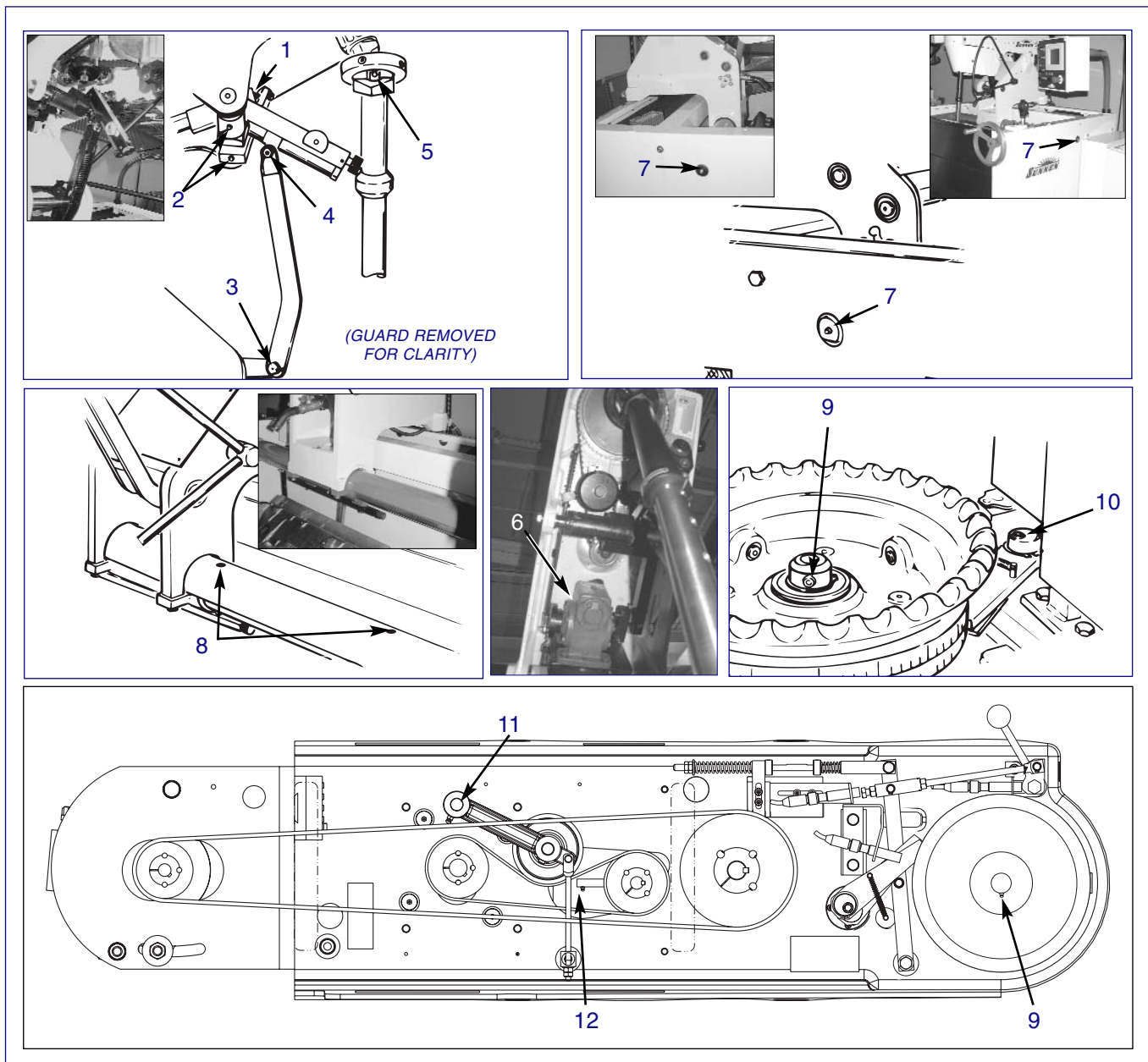


FIGURE 4-1, Lubrication

SECTION 4

ROUTINE MAINTENANCE

GENERAL

The following procedures and suggested maintenance periods are given as guides only and are not to be construed as absolute or invariable. Local conditions must always be considered. Each machine must be maintained individually according to its particular requirements.

CLEANING

Monthly, wipe exterior of Machine with a clean, dry cloth; then, clean exterior of Machine with warm water and a mild detergent or mild industrial solvent.

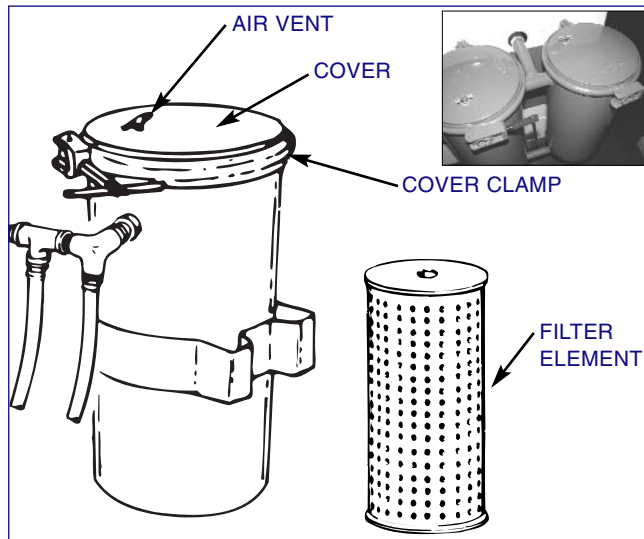


FIGURE 4-2, Filter Element Replacement

TABLE 4-1, Lubrication Points

#	DESCRIPTION	LUBRICANT	PROCEDURE	DAY	WEEK	MONTH	YEAR
1	Stroke Arm Assembly Needle Bearings (2 pts, front & rear)	#2 Grease	2 Pumps		Once		
2	Stroke Rocker Arm (2 pts, left & right)	#2 Grease	2 Pumps		Once		
3	Connecting Link Assembly (lower) Connects Lower Drive Arm to Carriage	#2 Grease	2 Pumps		Once		
4	Connecting Link Assembly (upper) Connects Upper Drive Arm to Carriage (Setscrew must be removed and grease fitting installed; grease fitting must be removed after applying grease and setscrew reinstalled.)	#2 Grease	Remove Plug & install fitting. 2 Pumps Remove fitting & replace Plug.			Once	
5	Upper Rod-feed Universal Joint	S.A.E. #20 Oil	Coat Universal		Once		
6	Gear Reducer (not shown)	Gear Oil 140	Drain and refill				Once
7	Carriage Traverse Shaft (both ends)	#2 Grease	2 Pumps each			Once	
8	Carriage Traverse Shaft (2 pts)	S.A.E.#20 Oil	2 Squirts each		Once		
9	Feed Handwheel Gears (not shown)	Lubriplate Low-Temp	Remove the Handwheel and repack Handwheel Gears.				Once
10	Feed Pawls	S.A.E. #20 Oil	Fill Oiler		Once		
11	Idler Arm Shaft	#2 Grease	1 Pump				Once
12	Gear Reducer Pulley Shaft (front pulley)	#2 Grease	1 Pump			Once	

Rinse thoroughly with clean, hot water and wipe dry.

LUBRICATION

Hand lubricate various machine components called out in [Figure 4-1](#), according to suggested intervals called out in [Table 4-1](#).

NOTE: The intervals between lubrication will vary with amount of use your machine receives. Lubricate all components at least once every six months.

COOLANT LINES CHECK

Monthly, inspect Coolant Lines and Fittings for leaks, severe dents or kinks. Tighten any leaking Fittings and replace damaged parts as required.

COOLANT LEVEL CHECK

Monthly, check level of Coolant in Coolant Reservoir and add Coolant as required by pouring coolant into Work Tray. Replace Coolant using **ONLY** Sunnen Industrial Honing Oil or Sunnen Water Based Coolant.

FILTER REPLACEMENT

Replace Filter Element in Filter Canister as follows ([see Figure 4-2](#)):

1. Turn OFF all electrical power to machine.
2. Open Air Vents in Canister Covers (turn counterclockwise).

3. Place a bucket under Draincocks on bottom of Filter Canisters, and drain about 2 quarts (2 liters) of oil from the canister to prevent spillage when removing dirty element.

4. Close Draincocks and air vents.

5. Loosen Cover Clamps. Remove clamps and Canister Covers.

6. Slowly pull out dirty Filter Elements and place in a bucket to drain.

7. Clean Filter Canisters as required.

8. Remove new Filter Elements from protective bags and insert in Filter Canisters; rotate elements slightly so it will slide down center post more easily.

NOTE: For best results use Sunnen PF105 or PF110 Filter Elements when using oil; or PF140 when using water-based coolant.

9. Replace Canister Covers and Cover Clamps. Tighten clamps.

NOTE: Ensure Seals are properly positioned before reinstalling Covers.

10. TURN ON electrical power.

11. Bleed Coolant System:

- Direct Coolant Nozzle downward and open Flow Control Knob.
- Turn ON power and start motors by pushing clutch lever all way back. Let pump run until all coolant nozzle delivers a steady stream of coolant.
- Pour an additional of approved coolant into Reservoir to top off system as Filter Canisters fill. The Coolant System holds a total of 208 liters (55 gallons) of coolant.
- Push POWER OFF Button.

12. Discard old Filter Element.

FILTER CANISTER CLEANING

Periodically clean Filter Canister as follows (see [Figure 4-3](#)):

1. Turn OFF all electrical power to machine.
2. Open Air Vents in Canister Covers (turn counterclockwise).
3. Place a suitable container under Draincocks on bottom of Filter Canisters, and drain oil from canisters.
4. Loosen Cover Clamps. Remove clamps and Canister Covers.
5. Slowly pull out dirty Filter Elements and place in a bucket to drain.
6. Remove Standpipes, using 1-1/2 in. (38 mm) open end wrench.
7. Scrape sludge from inside of canisters; use a long piece of wood or other soft material.

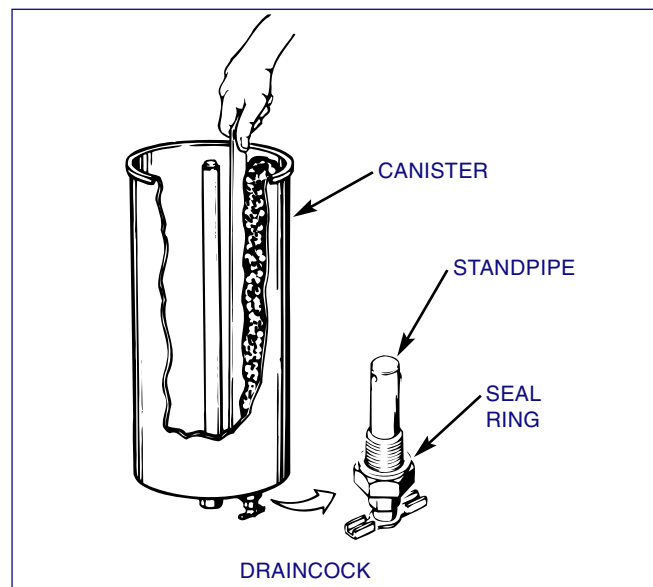


FIGURE 4-3, Filter Canister Cleaning

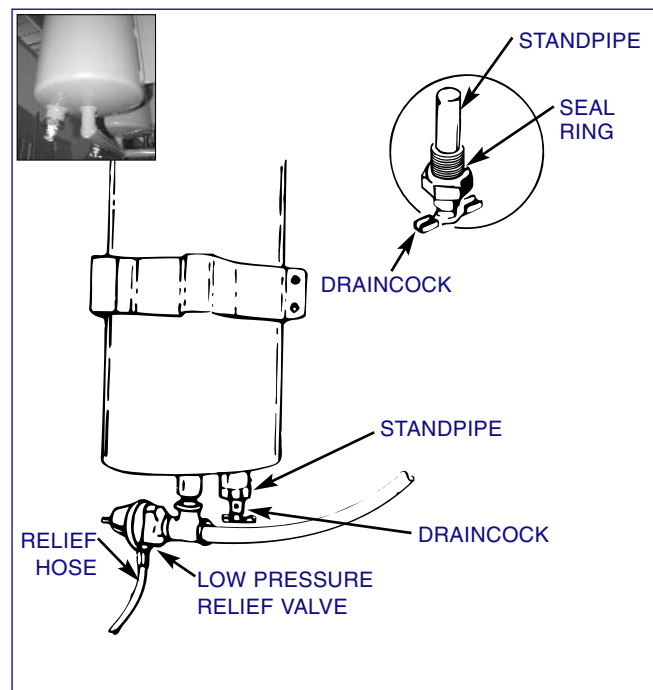


FIGURE 4-4, Filter Canister

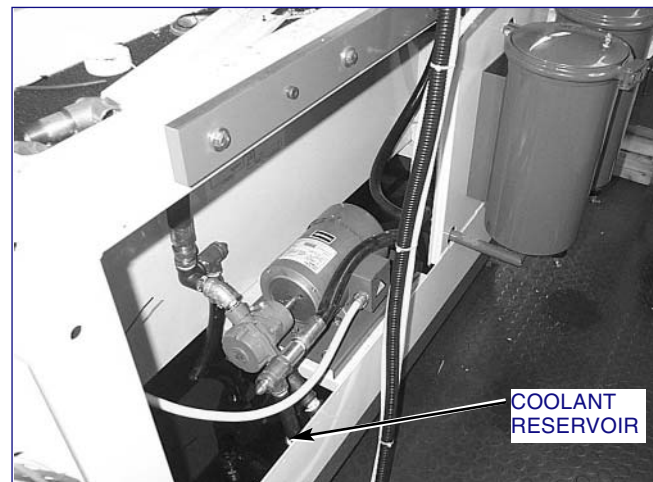


FIGURE 4-5, Coolant Reservoir

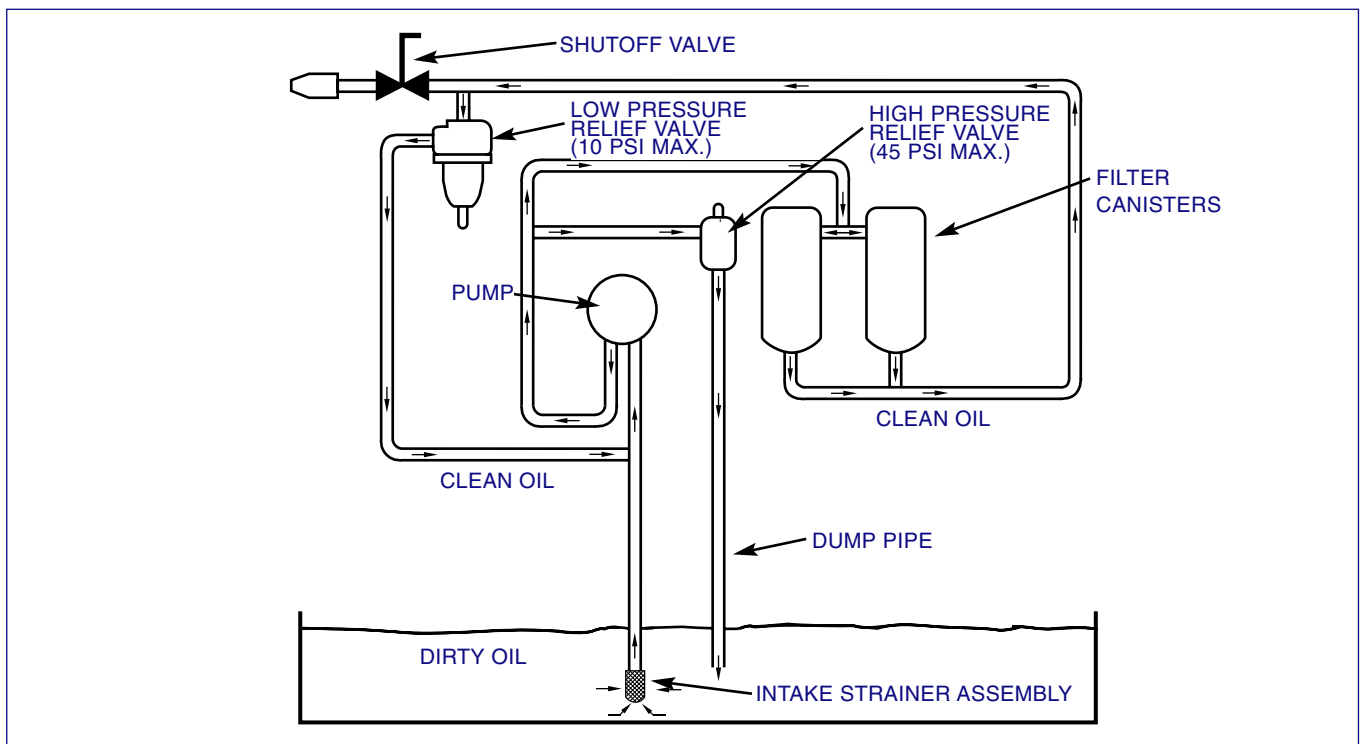


FIGURE 4-6, Oil Flow Diagram

8. Flush out remaining sludge with solvent.
Dispose of sludge.

9. Clean Standpipes and threaded fitting in Filter Canisters.

10. Inspect Standpipe Seal Rings and replace as necessary.

11. Coat Standpipe threaded fitting with Sealant and reinstall in Filter Canisters.

12. Close Draincocks and air vents.

13. Remove new Filter Elements from protective bag and insert in Filter Canisters; rotate element slightly so it will slide down center post more easily.

CAUTION

Ensure Seals are properly positioned before reinstalling Covers.

14. Replace Canister Covers and Cover Clamps. Tighten clamps.

15. Push POWER ON Button to start Coolant Pump Motor.

16. Bleed Coolant System:

- Direct Coolant Nozzle downward, and open Knob on Flow Control Manifold.
- Turn ON power and start motors by pushing clutch lever all way back. Let pump run until all coolant nozzle delivers a steady stream of coolant.
- Pour an additional 19 liters (5 gallons) of approved coolant into Reservoir to top off system as Filter Canisters fill. The Coolant System holds a total of 208 liters (55 gallons) of coolant.

- Push POWER OFF Button.

17. Discard old Filter Element.

COOLANT RESERVOIR CLEANING

Clean Coolant Reservoir as follows:

1. Turn OFF all electrical power to machine.
2. Lower Access Doors on front of machine.
3. Open Filter Door on rear of machine.
4. Open Air Vents in Canister Covers, by turning counterclockwise (see Figure 4-4).
5. Place a bucket under Draincocks on bottom of Filter Canisters, and drain coolant from the canisters.
6. Close Draincocks and air vents.
7. Clean and replace Filter Element.
8. Tip Settlement Tray and allow oil to drain into Reservoir (see Figure 4-5).
9. Remove Settlement Tray and clean.
10. Pump coolant from Reservoir.
11. Remove Intake Strainer from Intake Strainer Mounting Bracket.
12. Dip or pour out any coolant remaining in Reservoir.
13. Dip and scrape sludge from Reservoir.
14. Flush any remaining sludge from Reservoir and Settlement Tray with a mild industrial solvent, if necessary.
15. Wipe reservoir and tray dry.
16. Clean Intake Strainer as required.

17. Insert Intake Strainer into Intake Strainer Mounting Bracket.

18. Pump or pour Sunnen Industrial Honing Oil or Sunnen Water-Based Coolant into Coolant Reservoir.

19. Reinstall Settlement Tray.

20. Replace Filter Element and Filter Cover.

21. Bleed Coolant System (refer to Figure 4-6 on top of page 41):

- Direct Coolant Nozzle downward and open Flow Control Knob.
- Turn ON power and start motors by pushing clutch lever all way back. Let pump run until all coolant nozzle delivers a steady stream of coolant.
- Pour an additional of approved coolant into Reservoir to top off system as Filter Canisters fill. The Coolant System holds a total of 208 liters (55 gallons) of coolant.
- Push POWER OFF Button.

TIMING BELT ADJUSTMENT

Periodically check Timing Belt as follows (see Figure 4-7):

1. Push against Timing Belt with finger pressure. The Timing Belt should deflect no more than 6 mm (1/4 in.). To adjust, proceed as follows:

- Get a 9/16 in. and a 3/4 in. socket wrench.
- Loosen Timing Belt Idler Arm.
- Loosen Back Stop for Idler Arm.
- Rotate Back Stop into Idler Arm to increase tension, or rotate Stop away from Arm to decrease tension.
- Tighten Back Stop and Idler Arm.

2. Check belt for missing teeth. To replace, proceed as follows:

- Get a 1/2 in. end wrench and 9/16 in. and 3/4 in. socket wrenches.
- Remove Feed Push Rod from Feed Crank by removing Capscrew. DO NOT move Lock Nut; it will disturb length setting of Feed Push Rod.
- Loosen Idler Arm and Back Stop.
- Remove Timing Belt.
- Install new Belt, and adjust belt tension. Rotate Back Stop into Idler Arm to increase tension, or rotate Stop away from Arm to decrease tension.
- Tighten Back Stop and Idler Arm.
- Reconnect Feed Push Rod to Feed Crank.

SPINDLE DRIVE BELT ADJUSTMENT

To check or replace Spindle Drive Belt, proceed as follows (see Figure 4-8):

1. Turn OFF all power to Machine at Master ON/OFF Switch on front of Electrical Enclosure.
2. Remove Overarm Cover.

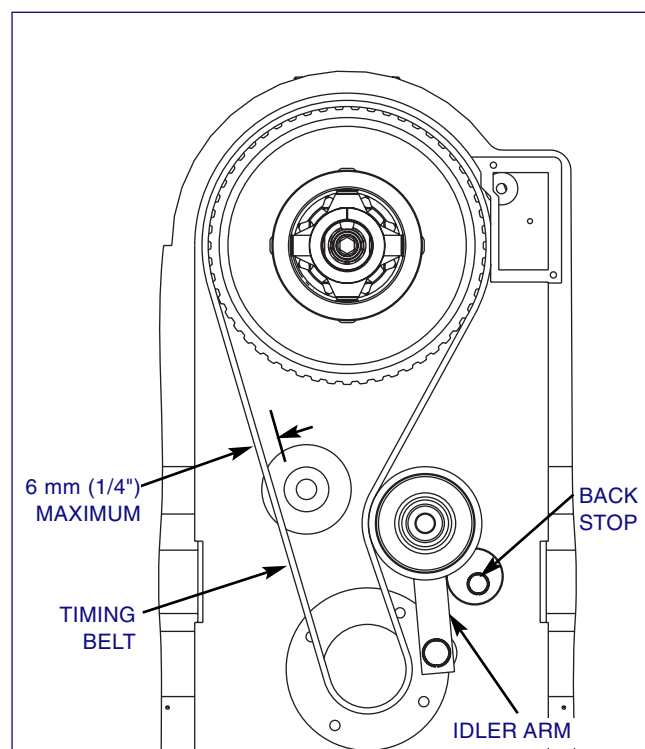


FIGURE 4-7, Timing Belt

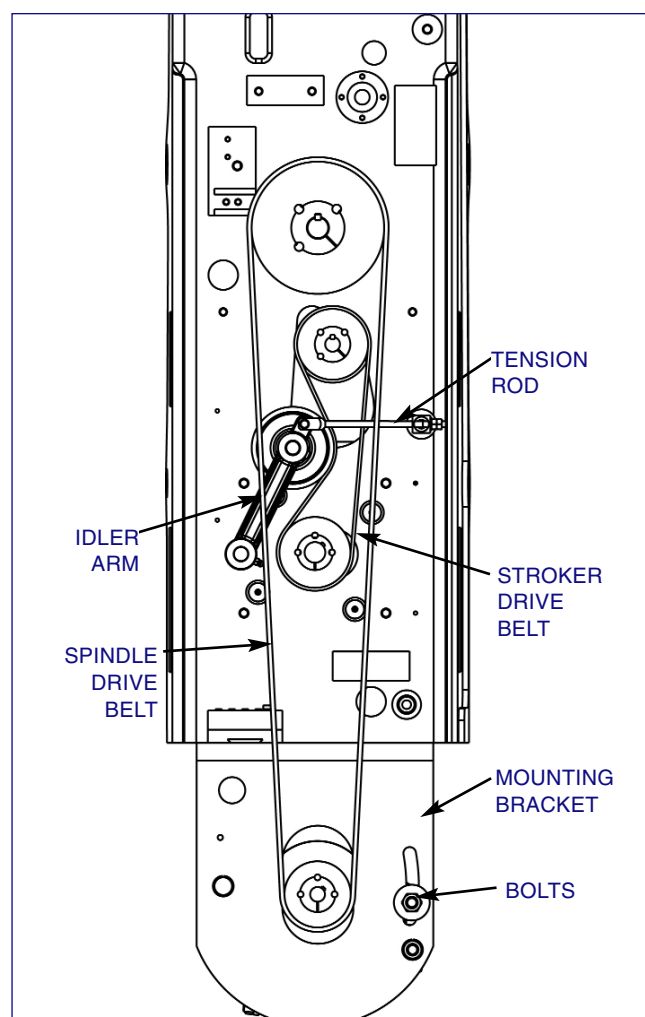


FIGURE 4-8, Drive Belts

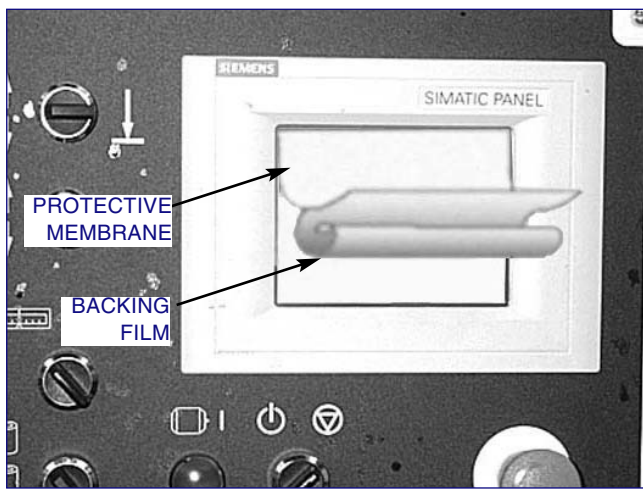


FIGURE 4-9, Touch Screen

3. Check belt for signs of wear or other visible damage. To replace, proceed as follows:

- Loosen two (2) Bolts in spindle motor Mounting Bracket, then loosen Tension Screw.
- Rotate Mounting Bracket forward to decrease tension and remove old Belt.
- Install new Belt
- Adjust Belt Tension by tightening Tension Screw until the belt deflects 3/8" when applying 6 lbs mid-span.
- Tighten two Bolts.

NOTE: While cover is off check Stroker Drive Belt (refer to following procedure.)

4. Reinstall Overarm Cover.

STROKER DRIVE BELT ADJUSTMENT

To check or replace Stroker Drive Belt, proceed as follows (*see Figure 4-8*):

1. Turn OFF all power to Machine at Master ON/OFF Switch on front of Electrical Enclosure.

2. Remove Overarm Cover.

3. Check belt for missing teeth, signs of wear or other visible damage. To replace, proceed as follows:

- Loosen Hex Nuts on end of idler pulley Tension Rod.
- Adjust Idler Arm and Tension Rod to decrease tension and remove old Belt.
- Install new Belt
- Adjust Belt Tension by adjusting Idler Arm and Tension Rod until the belt deflects 1/8" when applying 3 lbs mid-span.
- Secure Jam Nut to prevent slippage.

5. Reinstall Overarm Cover.

OPERATOR DISPLAY SCREEN

Turn OFF machine and clean Operator Display Screen at regular intervals, by wiping with a damp cloth.

WARNING

DO NOT clean screen while machine is turned ON. This ensures that functions are not inadvertently triggered on touching the keys or the touch screen. Inadvertent triggering of functions may cause a dangerous operating condition.

Use ONLY water, washing-up liquid, or screen cleaning foam applied to dampen cleaning cloth. DO NOT spray cleaning agent directly on screen. NEVER use aggressive solvents or scouring powder.

TOUCH SCREEN (Protective Membrane)

A protective membrane is installed on the touch screen before shipment. This membrane SHOULD remain in place for operation.

This self-adhesive membrane prevents touch screen from being scratched and soiled. In addition, the matt surface of the membrane reduces reflections.

This protective membrane can be removed as necessary without leaving any adhesive residue on the screen. (Refer to Repair Parts Catalog for reordering information.)

CAUTION

NEVER use sharp or pointed tools to remove the protective membrane, such as a knife for instance. This may cause damage to the touch screen and will VOID the warranty.

To replace Protective Membrane, proceed as follows:

1. Turn OFF power to the machine.
2. Remove old protective membrane, by using top right tongue without leaving a glue residue.
3. Clean touch screen with a soft cloth. (Use domestic cleaning agent if badly soiled.)
4. Loosen protective (backing) film on back of new membrane; and starting on top (wide side) pull back film half way (*see Figure 4-9*).
5. Stick membrane flush with upper broader of touch screen. (Slow press membrane down on screen, wiping out any air bubbles as you go.)
6. Remove protective film entirely and press membrane firmly onto touch screen.

NOTES

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SECTION 5

TROUBLESHOOTING

GENERAL

This section contains Troubleshooting information in table form which should be used when problems occur with machine. The table lists problems encountered, possible causes, and solutions for problems along with reference to section of manual where detailed instructions may be found to correct problems.

OPERATIONAL TROUBLESHOOTING

For suggestions on correcting problems with bore conditions or with honing operation; consult [Table 5-1](#).

TABLE 5-1, Operational Troubleshooting Index

PROBLEM	PROBABLE CAUSE	SOLUTIONS	SEC.
Tool generates high load	1. High feed rate	A. Lower feed rate	3
	2. Worn tool	A. Replace tool	2
	3. Tool Loading (Metal particles on tool surface)	A. Dress tool	3
		B. Increase tool's rpm C. Check coolant*	1
Slow stock removal	1. Inadequate tool feed rate	A. Increase feed rate	3
	2. Improper tool	A. Replace tool (courser grit tool)	2
	3. Improper or diluted coolant*	A. Check coolant*	1
Poor tool life	1. Excessive tool feed rate	A. Decrease feed rate	3
	2. Excessive stock removal	A. Decrease stock removal	3
	3. Improper tool	A. Replace tool	
	4. Improper or diluted coolant*	A. Check coolant*	1
	5. Inadequate tool rpm	A. Increase tool's rpm	3
Bellmouth	1. Improper stroke length	A. Shorten stroke length	3
	2. Excessive float in tool(s)	A. Decrease tool float	2
	3. Worn guide bushings	A. Replace bushings	4
Barrel	1. Improper stroke length	A. Increase stroke length	3
Taper in Open End	1. Part geometry or tool geometry	A. Readjust stroke position	3

***NOTE:** Many honing problems, such as poor tool life and rough finish, are caused by the following: the wrong coolant, insufficient coolant, dirty coolant, or contaminated coolant. Use ONLY clean, full-strength Sunnen Industrial Honing Oils or Water-Based Coolants. DO NOT dilute or "cut" the oil or coolant in your Machine with other oils or coolants. Keep solvents and cleaning fluids away from your Machine.

TABLE 5-1, Operational Troubleshooting Index (Cont'd)

PROBLEM	PROBABLE CAUSE	SOLUTIONS	SEC.
Out-Of-Round	1. Workpiece flexing (thinwall)	A. Decrease feed B. Change method of fixturing C. Decrease spindle speed D. Reduce stock removal	3 2
	2. Excessive float in tool(s)	A. Decrease tool float	
	3. Fixture not properly Aligned	A. Adjust Fixture	2
Rough Finish	1. Material loading tool	A. Inspect & clean	
	2. High feed rate	A. Decrease feed	3
	3. Improper tool	A. Use finer grit	
	4. Improper or diluted coolant*	A. Check coolant*	1
<p>*NOTE: Many honing problems, such as poor tool life and rough finish, are caused by the following: the wrong coolant, insufficient coolant, dirty coolant, or contaminated coolant. Use ONLY clean, full-strength Sunnen Industrial Honing Oils or Water-Based Coolants. DO NOT dilute or “cut” the oil or coolant in your Machine with other oils or coolants. Keep solvents and cleaning fluids away from your Machine.</p>			

GENERAL TROUBLESHOOTING INDEX

For suggestions on correcting problems due to improper machine setup or adjustment, consult [Table 5-2](#).

NOTE: Troubleshooting electrical components is a job for a qualified electrician; therefore, instructions are no more detailed than needed by such a qualified person. If you don't know how to perform the checks required, do not attempt to troubleshoot an electrical system.

TABLE 5-2, General Troubleshooting Index

PROBLEM	PROBABLE CAUSE	SOLUTIONS	SEC.
Motors do not start when Clutch Control Lever is pushed back. Light ON, but goes out when Lever is released.	<ol style="list-style-type: none"> 1. Motor Overload tripped. 2. Motor Starter defective. 3. Loose connections or broken communication wire. 	<ol style="list-style-type: none"> A. Press Reset Button. A. Replace Starter. A. Correct by securing wires properly. 	
Motors do not start when Clutch Control Lever is pushed back. Light OUT.	<ol style="list-style-type: none"> 1. Main Disconnect Switch is in "OFF" position. 2. Feed Handwheel is in "OFF" position (between 2.08 mm and 0). 3. Lift Lever not lowered. 2. Cycle Start Sensor not set properly or defective. 4. Lift Lever Safety Sensor is not set properly or defective. 5. Clutch Control Lever not contacting Cycle Start Sensor. 6. Fuse blown. 7. Loose connections or broken wire. 	<ol style="list-style-type: none"> A. Turn "ON" Switch. A. Increase Feed Handwheel setting. A. Lower Hone Tool into normal working position inside the workpiece. A. Adjust or replace Start Sensor (Prox. 2). A. Adjust or replace Safety Sensor (Prox. 1). A. Adjust Cycle Start Sensor (Prox. 2). A. Replace Fuse. There are three Fuses, only one of which is likely to be blown. A. Correct by securing wires properly. 	
Machine fails to dwell properly.	<ol style="list-style-type: none"> 1. Leads or connections associated with Dwell Control Button or defective switch PB1. 	<ol style="list-style-type: none"> A. Reconnect properly or replace. Refer to Wiring Diagram supplied with machine. 	
Machine fails to dwell properly. When Dwell is set to "CONT," but will Dwell when to "SINGLE."	<ol style="list-style-type: none"> 1. Dwell Control Button is defective. 2. Dwell Control Button not pressed for the full 2 seconds required. 	<ol style="list-style-type: none"> A. Replace Button. A. Hold Button down a minimum of 2 seconds. 	
Hone head chatters.	<ol style="list-style-type: none"> 1. Check Main Guide Shims. 2. Timing belt loose or teeth missing. 3. Gage Calibration improperly set. 4. Loose Universal Ring. 	<ol style="list-style-type: none"> A. Add or remove Shims as required. A. Adjust Belt Tension or replace Belt. A. Set Gage Calibration. A. Tighten Ring; four Screws should be tight. 	

TABLE 5-2, General Troubleshooting Index (Cont'd)

PROBLEM	PROBABLE CAUSE	SOLUTIONS	SEC.
Stones do not feed out. Shim fits.	1. Wedge was at end of its travel.	A. Add Shims.	
Stones do not feed out. Shim Does Not Fit, but Stones Do Not Expand.	1. Feed Handwheel set screw loose. 2. Broken Planetary Gears. 3. Broken Feed Rod. 4. Broken Wedge.	A. Tighten set screw. A. Replace Gear. A. Replace Feed Rod. A. Replace Wedge.	
Stones do not feed out. Shim Does Not Fit; Stones Expand, but Pawls are not moving.	1. Feed setting less than 1. 2. Variable Feed Ratchet set incorrectly. 3. Feed Overload Spring set incorrectly. 4. Feed Push Rod improperly connected.	A. Increase Feed setting. A. Adjust Ratchet. A. Adjust Spring. A. Adjust Feed Push Rod.	
Stones do not feed out. Shim Does Not Fit; Stones Expand, and Pawls are moving.	1. Clutch Mechanism improperly set. 2. Pawl Spring missing or broken.	A. Adjust Clutch Mechanism. A. Replace Spring.	
Machine does not shut off when Feed Handwheel reaches zero.	1. Feed Handwheel Auto Stop Sensor improperly set. 2. Defective Auto Stop Sensor or Cable.	A. Adjust Sensor (Prox. 4). A. Replace Sensor (Prox. 4) or Cable.	
Machine does not shut off when Clutch Lever is pushed.	1. Defective Analog Clutch Prox. Sensor. 2. Defective Clutch Mechanism.	A. Replace Sensor (Prox. 5). A. Adjust or replace Sensor (Prox. 2). B. Adjust or replace Mechanism.	
Machine does not shut off when Feed Handwheel reaches "0" & when Clutch Lever is pushed.	1. Cycle Start Sensor improperly set or defective. 2. Defective or misadjusted Auto Stop Sensor.	A. Adjust or replace Start Sensor (Prox. 2) A. Adjust or replace Sensor (Prox. 4).	
Machine "knocks" at end of each stroke.	1. Very high load. 2. Excessive carriage shoe clearance. 3. Loose or damaged Stroking Linkage.	A. Use softer stones. A. Adjust clearance. A. Adjust Linkage. B. Replace Linkage.	
"Motor ON" Indicator Light does not burn when motors are running.	1. Defective or burned out Bulb. 2. Loose connection.	A. Replace Bulb. A. Tighten connections.	

COOLANT FLOW DIAGRAM

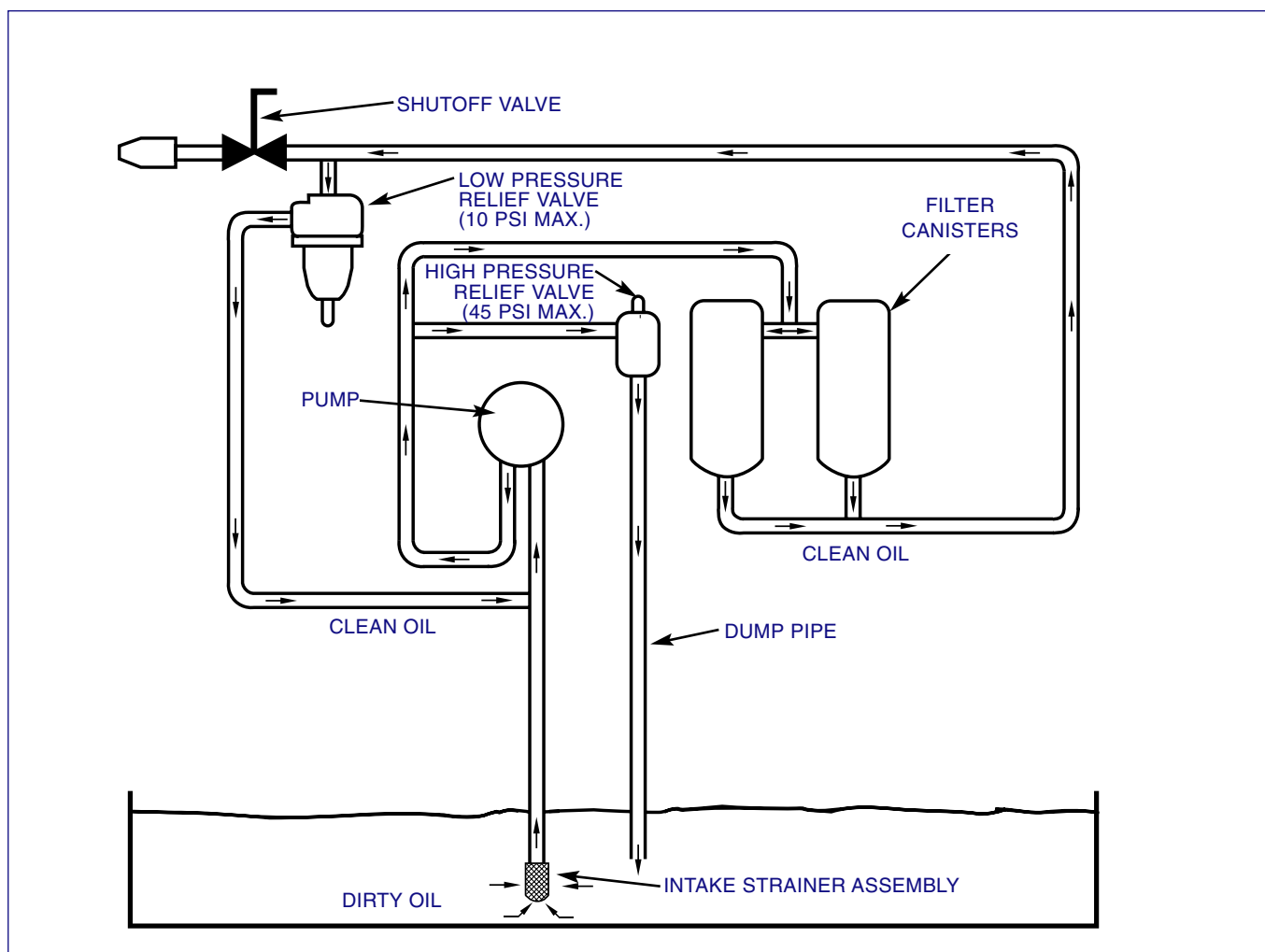


FIGURE A-1, Coolant Flow Diagram

ERROR MESSAGES SCREEN

Active Event Messages		
Adjust Graduated Feed Dial or Enter Honing Time Value		
Emergency Stop Depressed		
Coolant Pump Fault		
Stroke Motor Fault		
Spindle Motor Fault		
Start With Speed Greater Than 0		
Communications Fault - Please Reset		
Start Signal When Head Lowered Check Start Prox.		
		Engineering
System Reset	Setup Screen	Run Screen

Adjust Graduated Feed Dial or Enter Honing Time Value:

If in zero shut off mode, the machine will not start if the feed dial reads zero from the previous cycle. Adjust dial, press “system reset” and restart.

If in a timed cycle mode, the machine will not start unless there is a value other than zero in the display. Set time, press system reset, and restart.

Emergency Stop Depressed: Release Emergency Stop, press system reset and restart.

Coolant Pump Fault: Check that pump overload is not tripped. Press system reset and restart.

Spindle Motor Fault: Press system reset and restart. Contact Sunnen if problem persists.

Stroke Motor Fault: Press system reset and restart. Contact Sunnen if problem persists.

Start With Speed Greater Than 0: This indicates that the machine was attempting to start and also turn the spindle and stroker at a given speed when the clutch control handle was pushed rearward. This is purely a safety feature that prevents the machine from running unexpectedly. Verify that the Clutch proximity sensor is secure. Verify that the Clutch pivot screw is secure. Press system reset and restart.

Communication Fault: Occurs during Emergency stops and may occur if constant communication is not maintained between the PLC, Drives, And Operator Station. Press system reset to clear and restart. If problem persists, verify wiring is secure in cabinet. If problem continues, contact Sunnen.

Start Signal When Head Lowered Check Start Prox: This indicates that the machine was receiving a signal to start at the same time the head was being lowered. This is purely a safety feature that prevents the machine from running unexpectedly. Verify that the operator was not in contact with the clutch control lever when the head was lowered. If problem persists, verify that the Clutch proximity sensor is secure. Verify that the Clutch pivot screw is secure. Also verify that the Head proximity sensor and target are in adjustment. Press system reset to clear and restart.

ENGINEERING SCREEN

Engineering Screen				
<div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">Sensor Status</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;"> Top of Stroke <input type="button" value="OFF"/> Zero Shutoff <input type="button" value="OFF"/> Hone Head Down <input type="button" value="OFF"/> Cycle Start <input type="button" value="OFF"/> Clutch Prox <input type="button" value="< 100"/> </td> <td style="width: 50%; padding: 5px; border-left: 1px solid black;"> Total Cycle Time <input type="text" value="= 15"/> Graph Scale <input type="text" value="= 2.0"/> TYPE <input type="text" value="< 100"/> STEP <input type="text" value="< 100"/> </td> </tr> </table>			Top of Stroke <input type="button" value="OFF"/> Zero Shutoff <input type="button" value="OFF"/> Hone Head Down <input type="button" value="OFF"/> Cycle Start <input type="button" value="OFF"/> Clutch Prox <input type="button" value="< 100"/>	Total Cycle Time <input type="text" value="= 15"/> Graph Scale <input type="text" value="= 2.0"/> TYPE <input type="text" value="< 100"/> STEP <input type="text" value="< 100"/>
Top of Stroke <input type="button" value="OFF"/> Zero Shutoff <input type="button" value="OFF"/> Hone Head Down <input type="button" value="OFF"/> Cycle Start <input type="button" value="OFF"/> Clutch Prox <input type="button" value="< 100"/>	Total Cycle Time <input type="text" value="= 15"/> Graph Scale <input type="text" value="= 2.0"/> TYPE <input type="text" value="< 100"/> STEP <input type="text" value="< 100"/>			
Running Second <input type="text" value="< 20"/>				
Panel Settings	Setup Screen	Run Screen		

Sensor Status: Allows for troubleshooting of all machine sensors. Status of each sensor will toggle between ON & OFF when each function is performed. If a change in status is not seen, check switch for proper adjustment and make sure all cable connections are tight.

Total Cycle Time: Time in seconds the machine ran from when the Clutch Handle was pulled forward until the cycle ended. This number resets each time the Clutch Handle is pushed rearward.

Graph Scale: Graph Scale is a touch screen function that can be adjusted between two limits to adjust the magnification of the bore profile graph. (Tips: If spindle load is low, graph scale value should be set higher. If spindle load is high, graph scale value should be set lower.)

Running Second: Total spindle run time in seconds. This is a cumulative number that never resets.

Type: Should a persistent error occur, before any system reset, please record information presented in this field and have handy when calling for service.

Step: Should a persistent error occur, before any system reset, please record information presented in this field and have handy when calling for service.

PANEL SETTINGS SCREEN

SCREEN SETTINGS

Purpose

In order to be able to optimize reading from the screen according to varying light conditions and viewing angles, the following settings can be modified:

- **Set contrast** to compensate for varying lighting conditions when viewing from different angles
- **Calibrate screen** in order to compensate for the parallel axis, which is dependent on the installation position and angle of observation, and any operating errors which may occur as a result.
- **Set screen saver response time** - see below.

There are two ways to modify both the contrast and calibration settings:

- During the initialization phase of the operating unit
- During normal operation

Change screen settings in the initialization phase

Step 1 Switch on the power supply for the operating unit.

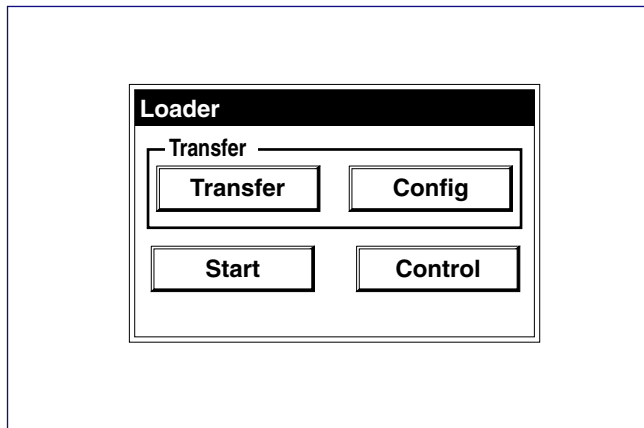


FIGURE 1, Initialization Screen Menu

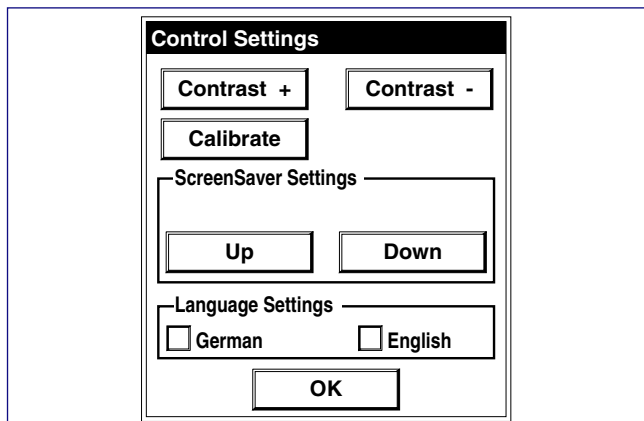


FIGURE 2, TP170A Control Settings Menu

Step 2 During initialization phase, the Initialization Screen Menu appears briefly (see Figure 1). Touch the Control button to call in the TP170A Control Settings Menu (see Figure 2).

Step 3 Touch the Contrast + and Contrast- buttons to change the contrast setting of the screen.

NOTE: Touch the buttons sufficiently long enough to detect contrast changes.

Step 4 Touch the Calibrate button with a touch pen in order to calibrate the screen.

Five calibration crosses appear in succession on the screen. Follow the instructions provided on the screen and touch the respective calibration cross.

Step 5 Apply calibration: Touch any point of the screen after the calibration process for the new calibration data to take effect

Reject calibration: Wait 30 seconds, until the seconds counter displayed has reached zero, before rejecting the new calibration data.

If calibration is not performed correctly, the new values are not accepted.

Step 6 Touch the OK button to close the Control Settings menu. The start menu then appears.

Save settings

The operating unit saves the current screen settings, backed up against a power failure, and sets them automatically when the system is switched on again.

Set screen saver response time

The TP170A has its own screen saver which is activated when the touch panel is not operated for a specified length of time. The screen saver is inactive by default.

In order to set the screen saver response time, use the Up and Down buttons in the TP170A Control Settings Menu (see Figure 2).

The screen saver is deactivated when system messages arrive. When the defined time has elapsed, it is reactivated.

On entering the value 0, the screen saver is deactivated permanently.

Like any machinery, this equipment may be dangerous if used improperly. Be sure to read and follow instructions for operation of equipment.

FRACTION / DECIMAL / MILLIMETER EQUIVALENTS CHART

INCH			INCH			INCH		
FRACTION	DECIMAL	MILLIMETER	FRACTION	DECIMAL	MILLIMETER	FRACTION	DECIMAL	MILLIMETER
....	.003937	0,1000	9/32	.281250	7,1438	21/32	.656250	16,6688
....	.007874	0,2000	19/64	.296875	7,5406	....	.669291	17,0000
....	.011811	0,3000	5/16	.312500	7,9375	43/64	.671875	17,0656
1/64	.015625	0,3969	....	.314961	8,0000	11/16	.687500	17,4625
....	.015748	0,4000	21/64	.328125	8,3344	45/64	.703125	17,8594
....	.019685	0,5000	11/32	.343750	8,7313	....	.708661	18,0000
....	.023622	0,6000	....	.354331	9,0000	23/32	.718750	18,2563
....	.027559	0,7000	23/64	.359375	9,1281	47/64	.734375	18,6531
1/32	.031250	0,7938	3/8	.375000	9,5250	....	.748031	19,0000
....	.031496	0,8000	25/64	.390625	9,9219	3/4	.750000	19,0500
....	.035433	0,9000	....	.393701	10,0000	49/64	.765625	19,4469
....	.039370	1,0000	13/32	.406250	10,3188	25/32	.781250	19,8438
3/64	.046875	1,1906	27/64	.421875	10,7156	....	.787402	20,0000
1/16	.062500	1,5875	....	.433071	11,0000	51/64	.796875	20,2406
5/64	.078125	1,9844	7/16	.437500	11,1125	13/16	.812500	20,6375
....	.078740	2,0000	29/64	.453125	11,5094	....	.826772	21,0000
3/32	.093750	2,3813	15/32	.468750	11,9063	53/64	.828125	21,0344
7/64	.109375	2,7781	....	.472441	12,0000	27/32	.843750	21,4313
....	.118110	3,0000	31/64	.484375	12,3031	55/64	.859375	21,8281
1/8	.125000	3,1750	1/2	.500000	12,7000	....	.866142	22,0000
9/64	.140625	3,5719	....	.511811	13,0000	7/8	.875000	22,2250
5/32	.156250	3,9688	33/64	.515625	13,0969	57/64	.890625	22,6219
....	.157480	4,0000	17/32	.531250	13,4938	....	.905512	23,0000
11/64	.171875	4,3656	35/64	.546875	13,8906	29/32	.906250	23,0188
3/16	.187500	4,7625	....	.551181	14,0000	59/64	.921875	23,4156
....	.196850	5,0000	9/16	.562500	14,2875	15/16	.937500	23,8125
13/64	.203125	5,1594	37/64	.578125	14,6844	....	.944882	24,0000
7/32	.218750	5,5563	....	.590551	15,0000	61/64	.953125	24,2094
15/64	.234375	5,9531	19/32	.593750	15,0813	31/32	.968750	24,6063
....	.236220	6,0000	39/64	.609375	15,4781	....	.984252	25,0000
1/4	.250000	6,3500	5/8	.625000	15,8750	63/64	.984375	25,0031
17/64	.265625	6,7469	....	.629921	16,0000	1	1.000000	25,4000
....	.275591	7,0000	41/64	.640625	16,2719	1-1/16	1.062500	26,9880

FORMULAS:

MULTIPLY BY TO GET
 INCHES (in) x 25.4 = MILLIMETERS (mm)
 FEET (ft) x 0.3048 = METERS (m)

MULTIPLY BY TO GET
 MILLIMETERS (mm) x 0.03937 = INCHES (in)
 METERS (m) x 3.281 = FEET (ft)

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